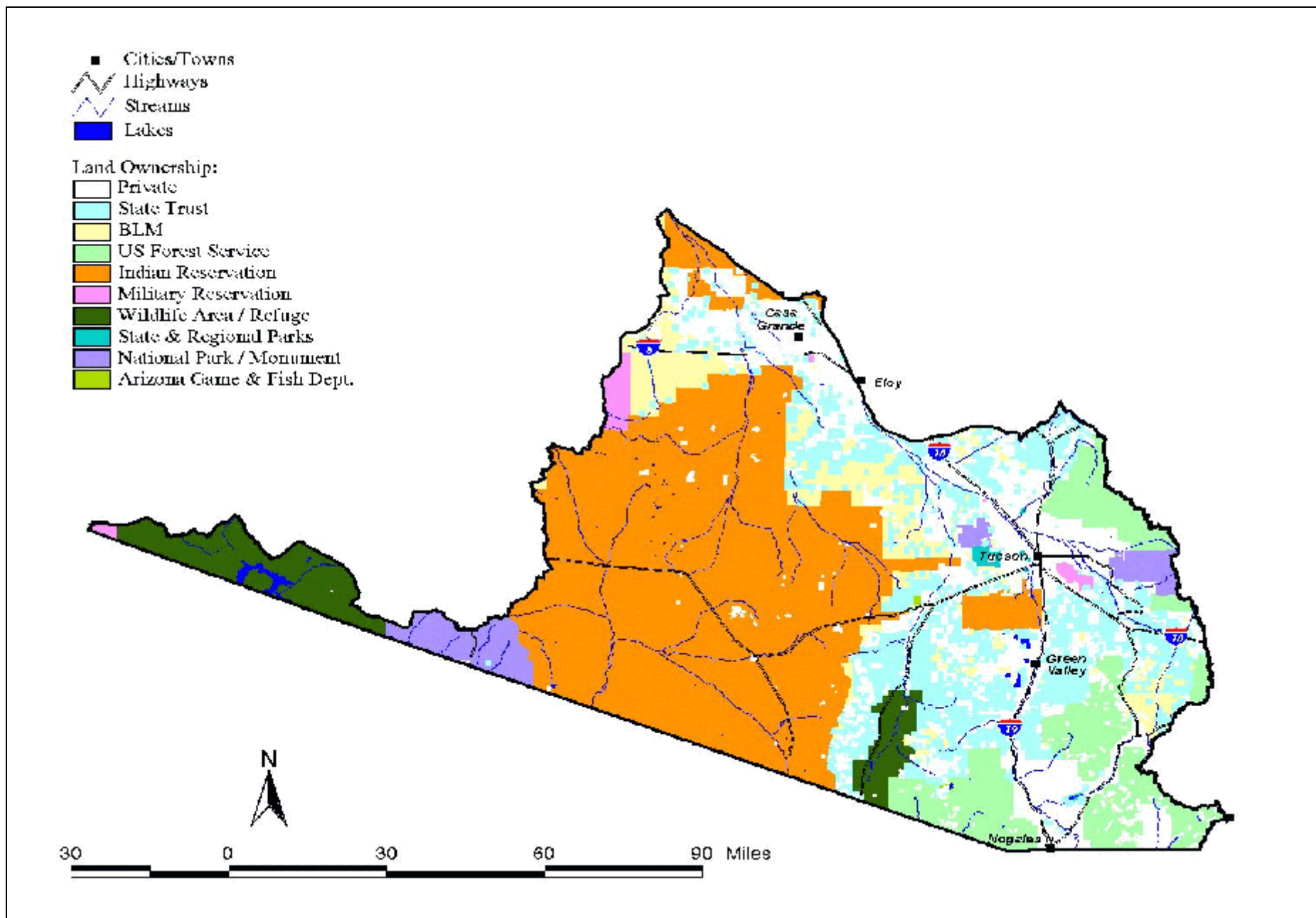


## Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed



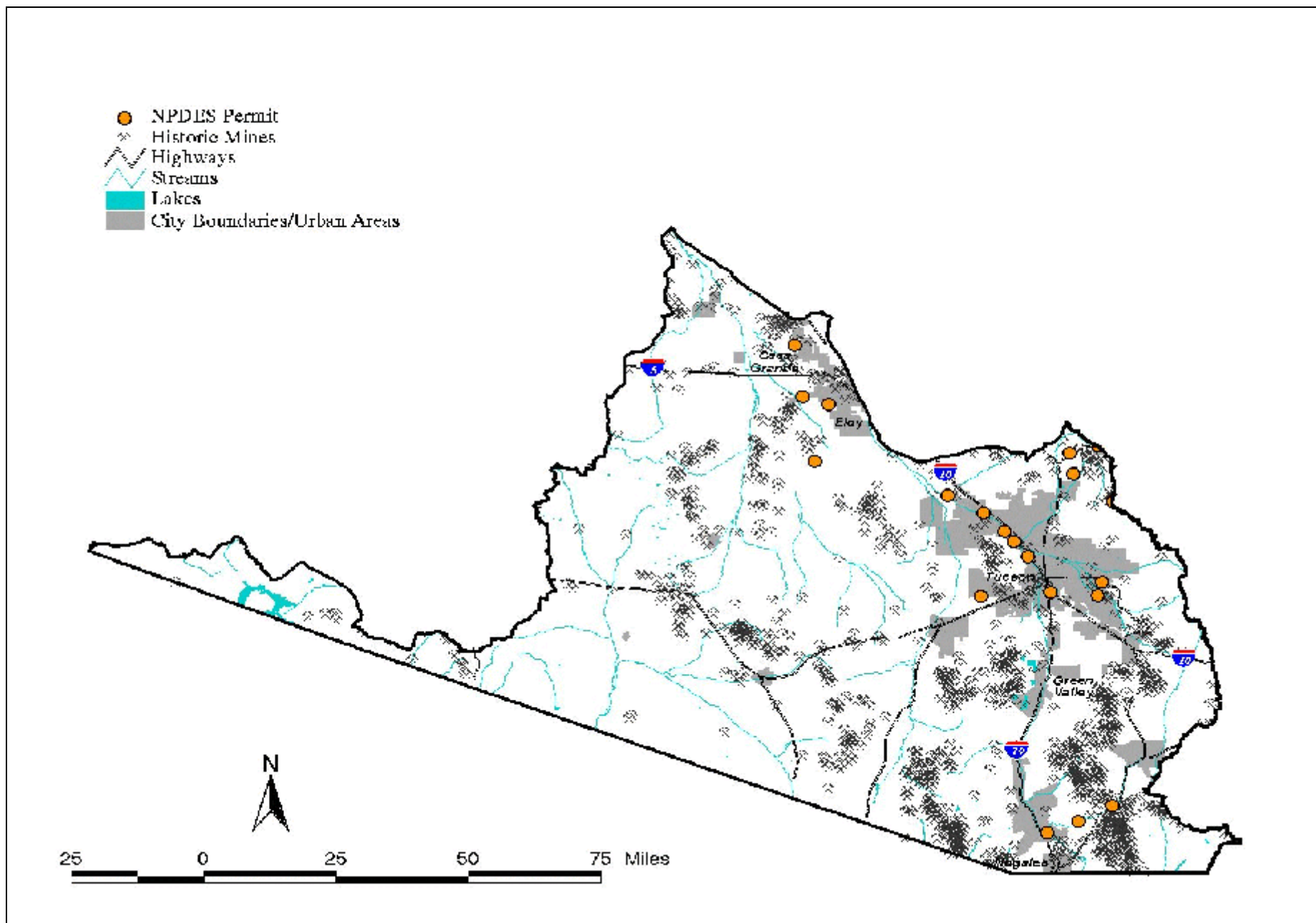
## SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED CHARACTERISTICS

SIZE	11,096 square miles (10% of the State's land area).					
POPULATION BASE	Approximately 933,811 people live in this watershed (estimated from the 2000 census). This is about 18% of the state's population.					
LAND OWNERSHIP (Figure 45)	Tribal	39%	US Forest Service	10%	Other state and federal	3%
	Private	22%	Bureau of Land Management	6%	Military lands	1%
	State	15%	National Wildlife Refuge	4%		
LAND USES AND PERMITS (Figure 46)	<p>Most of the population in this watershed is clustered around metropolitan Tucson (approximately 844,000 people), the state's second largest city. However, the combined population of Nogales in Arizona and in Sonora Mexico would be approximately 370,000, with 94% of this population in Mexico. Grazing and irrigated crop production (near stream beds) are the dominant land uses. Some of the agricultural land has been converted to urban use or retired where water rights have been purchased by mining or urban interests. Active mining is scattered across this watershed, but varies with the current market price. In addition, several abandoned mines are located within this watershed, several of which are under investigation as probable contributors of nonpoint source pollution.</p> <p>This watershed includes eight designated wilderness areas, along with National Forests and National Monuments with restricted land uses.</p>					
HYDROLOGY AND GEOLOGY	<p>This watershed is a composite of two surface water basins: 1) The Santa Cruz which flows north to the Gila River and 2) The Rio Magdalena and Rio Sonoyta drainage areas which flow south into Mexico. The maximum discharge of the Santa Cruz River is 33,000 cfs (in 1983 near its confluence with the Gila River). In recent years, no flow has been measured during most of the year (USGS 1996). Extensive ground water pumping has eliminated natural perennial flow in most of the Santa Cruz River. Wastewater provides perennial flow below discharges from the cities of Nogales (Arizona and Sonora, Mexico) and Tucson (Brown et al. 1978).</p> <p>Ground water basins and active management areas include: Cienega Creek, San Rafael, San Simon Wash, Tucson AMA, Santa Cruz AMA, Pinal AMA, and West Mexican Drainage. Generally, basin-fill sediments comprise the productive and widely used aquifers. Only minor amounts of ground water are found in the surrounding hardrock mountains in thin alluvial valley deposits and fractured bedrock (ADWR 1994).</p> <p>The primary Hydrologic Province is the Southern Basin and Range, with the southeastern corner of the watershed in Southern Deserts. This area is characterized by broad, gently-sloping alluvial basins, separated by fault block mountains that trend to the north to northwest.</p>					
UNIQUE WATERS	Cienega Creek (downstream portion)					
HYDROLOGIC PROVINCE(S)	Basin and Range Province.					
OTHER STATES, NATIONS, OR TRIBES	<p>This drainage area flows into the Middle Gila Watershed to the North. The headwaters of the Santa Cruz River flow south into Mexico for a distance before returning to the United States.</p> <p>Tohono O'odham, San Xavier, Pascua Yaqui, Ak Chin, and Gila River tribes are significant stakeholders in this watershed, occupying a 39% of the watershed.</p>					



**Figure 45. Land Ownership in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed**





**Figure 46. General Land Use and NPDES Permits in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed**

## Santa Cruz-Rio Magdalena, Rio Sonoyta Watershed Assessment Discussion

### Statistical Summary of Surface Water Assessments

**Assessments** – For the 2002 assessment, 168 miles of streams or washes and 552 acres of lakes were assessed. This assessment does not include the monitoring data generated in 2001 when this was one of two focus watersheds. That data will be included in the next assessment cycle.

Water quality assessment information for the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed is summarized in the following tables and illustrated in **Figure 47**.

**Table 24. Assessments in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed – 2002**

	STREAMS		LAKES	
	miles	number of segments	acres	number of lakes
ATTAINING	19	1	383	4
INCONCLUSIVE	100	8	7	1
IMPAIRED	69	10	0	0
NOT ATTAINING	0	0	169	2
TOTAL ASSESSED	188	19	559	7

PERENNIAL SURFACE WATERS ASSESSED		STREAMS		LAKES	
		miles	number of segments	acres	number of lakes
	Assessed	122	8	559	7

\* Note that streams with significant perennial stretches within the reach assessed were included in the perennial mileage although part of the reach may have ephemeral or intermittent flow.

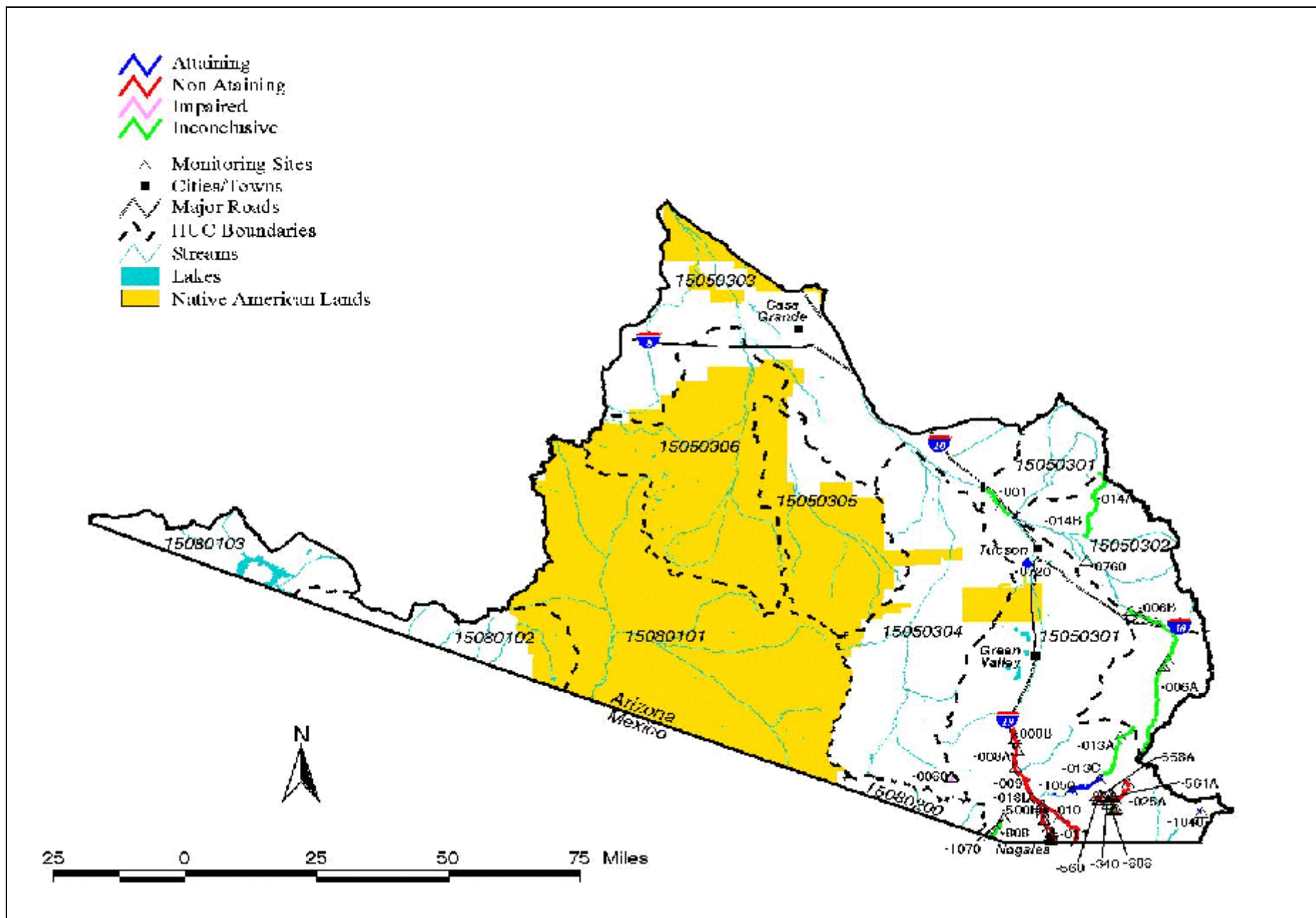
**Inconclusive Assessments** – Surface waters with some monitoring data, but insufficient data to determine if a designated use is attaining or impaired, were

added to the new Planning List. By the end of the next watershed monitoring cycle (scheduled in 2006), ADEQ expects to monitor most of these reaches so that all designated uses can be assessed during the following assessment cycle. Other lakes and streams which lack monitoring data will also be monitored depending on resources and priorities.

ADEQ will be working with US Geological Survey and the Arizona Game and Fish Department, so that their future monitoring efforts will better support Arizona's surface water assessments.

**Major Stressors** – When a surface water is listed as impaired or not attaining a designated use, the pollutants or suspected pollutants causing the impairment are identified. The reaches and lakes assessed as impaired or not attaining their uses in this watershed can be divided into four groups based on pollutants and their probable sources:

- Deteriorated municipal wastewater infrastructure in Mexico and the under-designed Nogales International Wastewater Treatment Facility has lead to six stream reaches (51 miles) being assessed as impaired by bacteria, chlorine, and/or cyanide. (See Border Program discussion in Chapter VII of Volume 1.)
- Historic mining activities have cause impairment of four stream reaches (19 miles) due to metals (primarily copper and zinc).
- Mercury contamination of fish tissue has lead to fish consumption advisories and mercury TMDLs at two lakes, Arivaca and Pena Blanca. Historic deposition, air deposition, and mercury cycling in the lakes have contributed to this problem. Further monitoring is being scheduled to determine the effectiveness of TMDL implementation strategies.
- High turbidity is also impairing Nogales Wash.



**Figure 47. Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed Surface Water Assessments – 2002**

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
STREAM MONITORING DATA								
Alum Gulch headwaters-ephemeral reach AZ15050301-561A A&Ww, FC, FBC, AgL	ADEQ TMDL Monitoring Below World's Fair Mine SCALG004.61 100870	1999 - 1 field, dissolved/total cadmium, copper, zinc  2000 - 1 field, dissolved/total cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	3.2 - 3.2	2 of 2		Not all core parameters sampled.
			Cadmium (dissolved) µg/L	115 (A&Ww)	170 - 220	2 of 2		
			Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	170 - 290	2 of 2 2 of 2 2 of 2		
			Copper (dissolved) µg/L	65 (A&Ww)	1600 - 2000	2 of 2		
			Copper (total) µg/L	500 (AgL)	1900 - 2100	2 of 2		
			Zinc (dissolved) µg/L	379 (A&Ww)	49,000 -53,000	2 of 2		
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL 42,000 - FBC	45,000-54,000	2 of 2 2 of 2 2 of 2		
	ADEQ TMDL Monitoring Below January Adit SCALG004.82 100317	1998 - 3 field, dissolved/total cadmium, copper, zinc (4) nutrients	Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	27 - 191	2 of 3 2 of 3 2 of 3		Not all core parameters sampled.
			Copper (dissolved) µg/L	56 - 305 (A&Ww)	1600 - 2000	3 of 3		
			Copper (total) µg/L	500 (AgL)	1900 - 2100	3 of 3		
			Zinc (dissolved) µg/L	328 - 1512 (A&Ww)	49,000 -53,000	3 of 3		
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL 42,000 - FBC	7,680 - 54,900	2 of 3 2 of 3 2 of 3		
	ADEQ TMDL Monitoring Below Alum Falls and above World's Fair Mine SCALG004.98 100836	1999 - 1 field, dissolved/total cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	3.5	1 of 1		Not all core parameters sampled.
			Cadmium(dissolved) µg/L	115 (A&Ww)	160	1 of 1		
			Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	160	1 of 1 1 of 1 1 of 1		

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					COMMENTS
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	
			Copper (dissolved) µg/L	65 (A&Ww)	1500	1 of 1		
			Copper (total) µg/L	500 (AgL)	1400	1 of 1		
			Zinc (dissolved) µg/L	379 (A&Ww)	46,000	1 of 1		
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL 42,000 - FBC	49,000	1 of 1 1 of 1 1 of 1		
	ADEQ TMDL Monitoring Below Humboldt Canyon, and above Alum Falls SCALG005.30 100837	1999 - 1 field, dissolved/total cadmium, copper, zinc	Cadmium(dissolved) µg/L	115 (A&Ww)	150	1 of 1		Not all core parameters sampled.
			Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	180	1 of 1 1 of 1 1 of 1		
			Copper (dissolved) µg/L	65 (A&Ww)	1200	1 of 1		
			Copper (total) µg/L	500 (AgL)	1200	1 of 1		
			Zinc (dissolved) µg/L	379 (A&Ww)	44,000	1 of 1		
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL	41,000	1 of 1 1 of 1		
			pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	3.6	1 of 1		
	ADEQ TMDL Monitoring Above Humboldt Canyon SCALG005.58 100838	1999 - 1 field, dissolved/total cadmium, copper, zinc 2000 - 1 field, dissolved/total cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	4.5 - 5.3	2 of 2		Not all core parameters sampled.
			Cadmium(dissolved) µg/L	115 (A&Ww)	120 - 170	2 of 2		
			Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	140 - 180	2 of 2 2 of 2 2 of 2		
			Copper (dissolved) µg/L	65 (A&Ww)	110 - 400	2 of 2		
			Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	0.49 - 7.1 (73 - 84% saturation)	1 of 2		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment.



**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
			Zinc (dissolved) µg/L	379 (A&Ww)	39,000 -56,000	2 of 2		Not all core parameters sampled.
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL 42,000 - FBC	42,000-56,000	2 of 2 2 of 2 1 of 2		
	ADEQ TMDL Monitoring Below Trench Camp Mine and above January Adit SCALG005.90 100839	1999 - 1 field, dissolved/total cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	5.9	1 of 1		Not all core parameters sampled.
			Zinc (dissolved) µg/L	127 (A&Ww)	2500	1 of 1		
	<b>Summary Row</b>  A&Ww      Impaired FC          Inconclusive FBC        Inconclusive AgL        Inconclusive	1998-1999  10 samples 5 sampling events  Missing core parameters	pH SU	6.5 - 9.0 (low) (A&Ww, FBC, AgL)	3.2 - 5.9	7 of 7	Inconclusive	ADEQ collected 10 samples at six sites from 1998 - 2000. Reach is assessed as impaired due to dissolved metals. Reach is also added to the Planning List for total metals, low pH, and missing core parameters.
			Cadmium (dissolved) µg/L	Varies (A&Ww)	56 - 220	6 of 10	Impaired	
			Cadmium (total) µg/L	41 - FC 50 - AgL 70 - FBC	27 - 290	8 of 9 8 of 9 8 of 9	Inconclusive	
			Copper (dissolved) µg/L	Varies (A&Ww)	110 - 2000	9 of 10	Impaired	
			Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	0.5 - 7.1 (73 - 84% saturation)	1 of 10	Attaining	
			Zinc (dissolved) µg/L	Varies (A&Ww)	2,500 - 56,000	10 of 10	Impaired	
			Zinc (total) µg/L	22,000 - FC 25,000 - AgL 42,000 - FBC	7,680 - 56,000	8 of 9 8 of 9 6 of 9	Inconclusive	
Cienega Creek headwaters-Interstate 10 AZ15050302-006A A&Ww, FC, FBC, AgL	ADEQ Stream Ecosystem Monitoring Below Stevenson Canyon SCCIE012.38 100601	1998 - 1 suite	OK					Missing core parameter: E. coli.
	ADEQ Biocriteria Program Above the Narrows SCCIE012.55 100480	1998 - 1 suite	OK					Missing core parameter: E. coli.

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	ADEQ Stream Ecosystem Below Tilted Beds SCCIE011.80 100600	1998 - 1 suite	OK					Missing core parameter: E. coli.
	<b>Summary Row</b>  <b>A&amp;Ww</b> <b>Inconclusive</b> <b>FC</b> <b>Inconclusive</b> <b>FBC</b> <b>Inconclusive</b> <b>AgL</b> <b>Inconclusive</b>	<b>1998</b>  <b>3 samples</b> <b>1 sampling event</b> <b>Missing a core</b> <b>parameter</b>	OK				Inconclusive	ADEQ collected samples at 3 sites in 1998. Reach is assessed as "inconclusive" and will be added to Planning List due to a lack of sampling events, seasonal coverage, and no bacteria samples.
Cienega Creek Interstate 10-Del Lago Dam AZ15050302-006B A&Ww, FBC, FC, AgL	ADEQ Stream Ecosystem Monitoring Above Diversion Dam SCCIE000.42 100595	1998 - 1 suite	Dissolved oxygen mg/l	6.0 (90% saturation) (A&Ww)	4.6 (54% saturation)	1 of 1		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment. Missing core parameter: E. coli.
	ADEQ Stream Ecosystem Monitoring At Marsh Station Road SCCIE001.07 100263	1998 - 1 suite	Ok					Missing core parameter: E. coli.
	ADEQ Stream Ecosystem Monitoring Above Davidson Canyon SCCIE001.20 100598	1998 - 1 suite	Dissolved oxygen mg/l	6.0 (90% saturation)	5.4	1 of 1		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment. Missing core parameter: E. coli.
	ADEQ Stream Ecosystem Monitoring Below tilted beds SCCIE003.5 100599	1998 - 1 suite	Ok					Missing core parameter: E. coli.
	<b>Summary Row</b>  <b>A&amp;Ww</b> <b>Inconclusive</b> <b>FC</b> <b>Inconclusive</b> <b>FBC</b> <b>Inconclusive</b> <b>AgL</b> <b>Inconclusive</b>	<b>1998</b>  <b>4 samples</b> <b>1 sampling event</b> <b>Missing a core</b> <b>parameter</b>	OK				Inconclusive	ADEQ collected samples at 4 sites in 1998. Reach is assessed as "inconclusive" and will be added to the Planning List due to insufficient sampling events, seasonal coverage, and lack of bacteria samples.
Cox Gulch headwaters-Three R Canyon AZ15050301-560 A&Ww, FBC, FC, AgL	ADEQ TMDL Monitoring Below Cox Gulch and canyon leading to European Mine SCCXG000.85 100869	1999 - 1 pH, total/dissolved beryllium, cadmium, copper, zinc 2000 - 1 pH, total/dissolved beryllium, cadmium, copper, zinc	Copper (dissolved) µg/L	49-65 (A&Ww)	8200 - 18,000	2 of 2		
			Cadmium (total) µg/L	41 - FC 70 - FBC	35 - 72	1 of 2 1 of 2		
			Beryllium (total) µg/L	0.21 (FC)	8 - 12	2 of 2		

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					COMMENTS
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	
			pH SU	6.5 - 9.0 (A&Ww, FBC)	3.3	1 of 1		
			Zinc (dissolved) µg/L	290-379 (A&Ww)	3200 - 11,000	2 of 2		
	ADEQ TMDL Monitoring At European Mine canyon SCCXG001.02 100875	1999 - 1 total/dissolved beryllium, cadmium, copper, zinc	Copper (dissolved) µg/L	44 (A&Ww)	7600	1 of 1		
			Zinc (dissolved) µg/L	264 (A&Ww)	2900	1 of 1		
			Beryllium (total) µg/L	0.21 (FC)	7.4	1 of 1		
	ADEQ TMDL Monitoring Above European Mine canyon SCCXG001.04 100876	1999 - 1 total/dissolved beryllium, cadmium, copper, zinc	Copper (dissolved) µg/L	65 (A&Ww)	8000	1 of 1		
			Zinc (dissolved) µg/L	379 (A&Ww)	5900	1 of 1		
			Beryllium (total) µg/L	0.21 (FC)	7.4	1 of 1		
	Summary Row  A&Ww      Impaired FC        Inconclusive FBC       Inconclusive AgL       Inconclusive	1999-2000  4 samples 2 sampling events  Missing core parameters	Copper (dissolved) µg/L	Varies (A&Ww)	8200 - 18,000	4 of 4	Impaired	ADEQ collected 4 samples at 3 sites from 1999 - 2000. Reach assessed as impaired due to dissolved metals. Reach also added to the Planning List due to total metals, pH, and missing core parameters.  Impairment will be addressed through the Three R Canyon TMDL in progress.
			Cadmium (total) µg/L	41 - FC 70 - FBC	35 - 72	1 of 4	Inconclusive	
			Beryllium (total) µg/L	0.21 (FC)	7.2 - 12	4 of 4	Inconclusive	
			pH SU	6.5 - 9.0 (low) (A&Ww, FBC)	3.3	1 of 4	Inconclusive	
			Zinc (dissolved) µg/L	Varies (A&Ww)	2,900 - 11,000	4 of 4	Impaired	
Endless Mine Tributary headwaters-Harshaw Creek AZ15050301-888 A&We, PBC	ADEQ TMDL Monitoring above Endless Chain Mine SCHRS000.38 100850	1999 - 1 field, total/dissolved copper & zinc	pH SU	6.5 - 9.0 (A&We, PBC)	6.2	1 of 1		
	ADEQ TMDL Monitoring above mine-impacted area SCHRS000.56 100851	1999 - 2 field, total/dissolved copper & zinc	Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	5.7 - 6.94 (75 - 94% saturation)	1 of 2		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment.
			pH SU	6.5 - 9.0 (A&We, PBC)	5.2 - 6.3	2 of 2		

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	<b>Summary Row</b>  A&We Inconclusive PBC Inconclusive	<b>1998-1999</b>  3 samples 2 sampling events Missing core parameters	pH SU	6.5 - 9.0 (A&We, PBC)	5.2-6.3	3 of 3	Inconclusive	ADEQ collected 3 samples at 2 sites from 1998 - 1999. Reach should be added to the Planning List due to low pH and missing core parameters.
Harshaw Creek headwaters-ephemeral seg. AZ15050301-025A A&Ww, FC, FBC, AgL	ADEQ TMDL Monitoring Below Trench Camp Mine SCHRS011.56 100319	1998 - 4 nutrients, total/dissolved copper, zinc	Copper (total) µg/L	500 (AgL)	16 - 620	1 of 4		
			Zinc (dissolved) µg/L	varies (A&Ww)	170 - 860	3 of 4		
	ADEQ TMDL Monitoring At lowest observed water SCHRS003.0 100318	1998 - 4 nutrients, total/dissolved copper, zinc	OK					
	ADEQ TMDL Monitoring Below Endless Chain Mine Cyn SCHRS013.63 100848	1999 - 1 field, total/dissolved copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	4.6	1 of 1		
			Copper (dissolved) µg/L	10 (A&Ww)	62	1 of 1		
			Zinc (dissolved) µg/L	73 (A&Ww)	190	1 of 1		
	<b>Summary Row</b>  A&Ww Impaired FC Inconclusive FBC Inconclusive AgL Inconclusive	<b>1998-1999</b>  9 samples 5 sampling events Missing core parameters	Copper (total) µg/L	500 (AgL)	16 - 620	1 of 9	Inconclusive	ADEQ collected 9 samples at three sites from 1998 - 1999. Reach is assessed as impaired due to dissolved zinc. Reach should be added to the Planning List due to copper, low pH, and missing core parameters.
			Copper (dissolved) µg/L	Varies (A&Ww)	10 - 62	1 of 9	Inconclusive	
			pH SU	6.5 - 9.0 (low) (A&Ww, FBC, AgL)	4.6 - 6.3	1 of 9	Inconclusive	
			Zinc (dissolved) µg/L	Varies (A&Ww)	42 - 860	4 of 9	Impaired	
Humboldt Canyon headwaters-Alum Gulch AZ15050301-340 A&Ww, FBC, FC, AgL	ADEQ TMDL Monitoring Lower Humboldt Canyon at base of falls, above Humboldt SCHMC001.27 100840	1999 - 1 field, total/dissolved cadmium, copper, and zinc	pH SU	6.5-9.0 (A&Ww, FBC, AgL)	3.6	1 of 1		
			Copper (dissolved) µg/L	4 (A&Ww)	140	1 of 1		
			Zinc (dissolved) µg/L	30 (A&Ww)	85	1 of 1		
	ADEQ TMDL Monitoring Upper Humboldt Canyon, At Jeep Road SCHMC002.41 100841	1999 - 1 field, total/dissolved cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC, AgL)	3.3	1 of 1		
			Copper (dissolved) µg/L	7 (A&Ww)	540	1 of 1		

TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED – MONITORING DATA – 2002 ASSESSMENT									
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID		YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
				PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
				Copper (total) µg/L	500 (AgL)	550	1 of 1		
				Zinc (dissolved) µg/L	49 (A&Ww)	210	1 of 1		
	Summary Row  A&Ww      Inconclusive FC        Inconclusive FBC       Inconclusive AgL       Inconclusive		1999  2 samples 1 sampling event  Missing core parameters	pH SU	6.5 - 9.0 (low) (A&Ww, FBC, AgL)	3.3 - 3.6	2 of 2	Inconclusive	Insufficient sampling events to assess. Add to Planning List.
				Copper (dissolved) µg/L	Varies (A&Ww)	140 - 540	2 of 2	Inconclusive	
				Copper (total) µg/L	500 (AgL)	160 - 550	1 of 2	Inconclusive	
				Zinc (dissolved) µg/L	49 (A&Ww)	85 - 210	2 of 2	Inconclusive	
	Nogales and E. Nogales Wash Mexico border-Santa Cruz River AZ15050301-011 A&Ww, PBC	ADEQ Fixed Station Network At West Produce Row Bridge SCNGW001.7 100697		1998 - 1 total chlorine	Chlorine µg/L	11	50	1 of 1	
ADEQ Fixed Station Network At East Calle Sonora Road SCNGW002.6 100699		1998 - 1 total chlorine	Chlorine µg/L	11	140	1 of 1			
ADEQ Stream Ecosystem Monitoring Near public works building SCNGW003.15 100206		1998 - 1 suite (no bacterial samples)	Chlorine µg/L	11	140	1 of 1			
ADEQ Fixed Station Network At West Produce Row Bridge SCNGW003.4 100700		1998 - 1 total chlorine	Chlorine µg/L	11	300	1 of 1			
ADEQ Fixed Station Network At West Produce Row Bridge SCNGW003.8 100701		1998 - 1 total chlorine	Chlorine µg/L	11	380	1 of 1			
ADEQ Fixed Station Network At Morley Street Tunnel SCNGW004.23 100251		1996 - 5 suites 1997 - 4 suites 1998 - 5 suites 1999 - 4 suites 2000 - 4 suites	Ammonia mg/l	varies (7.8) (A&Ww)	<0.1 - 9.0	1 of 20			
			Arsenic µg/L	50 (PBC)	<10 - 65	1 of 22			
			Chlorine (free) µg/L	11 (A&Ww)	70 - 2830	21 of 21			



TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED – MONITORING DATA – 2002 ASSESSMENT									
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT						
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS	
			Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	4.4 - 9.6 (62%-108% saturation)	3 of 21			
			Fecal coliform CFU/100 ml	4000 (A&Ww, PBC)	0 - >1,000,000	3 of 16			
			Turbidity NTU	50 (A&Ww)	1.51 - 2730	5 of 22			
	Summary Row		1996 - 2000  27 samples 24 sampling events	Ammonia mg/l	varies (7.8) (A&Ww)	<0.1 - 9.0	1 of 21	Attaining	ADEQ collected 27 samples at 6 sites from 1996 - 2000. Reach assessed as “impaired” due to chlorine, fecal coliform, and turbidity.  Deteriorated wastewater treatment infrastructure in Mexico has resulted in increased levels of fecal coliform and, consequently chlorine has been added directly to the stream at high levels to minimize public health concerns.
	A&Ww	Impaired		Arsenic µg/L	50 (PBC)	<10-65	1 of 23	Attaining	
	PBC	Impaired		Chlorine (free) µg/L	11 (A&Ww)	70 - 2830	26 of 26	Impaired	
				Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	4.4 - 9.6 (62% - 108% saturation)	3 of 22	Attaining	
				Fecal coliform CFU/100 ml	4000 (A&Ww, PBC)	0 - >1,000,000	3 of 16 4 in 3 years	Impaired	
				Turbidity NTU	50 (A&Ww)	1.51 - 2730	5 of 23	Impaired	
	Pena Blanca Canyon Creek Mexico bdr-Pena Blanca Lake AZ15050301-808 A&Ww, FBC, FC, AgL, AgI	AGFD Lakes Program At springs	1997 - 1 suite	OK					Missing core parameters: turbidity, flow, dissolved metals, bacteria, and boron.
AGFD Lakes Program At International Border		1997 - 1 suite	OK				Missing core parameters: turbidity, flow, dissolved metals, bacteria, and boron		
Summary Row A & Ww Inconclusive FBC Inconclusive FC Inconclusive AgI Inconclusive AgL Inconclusive		1997  2 samples 1 sampling event Missing core parameters	OK				Inconclusive	AGFD collected 2 samples at two sites in 1997. Insufficient parametric coverage and sampling events to assess.	
Potrero Creek Interstate19-Santa Cruz River AZ15050301-500B A&Ww, FC, FBC, AgL	ADEQ Fixed Station Network At Santa Cruz River SCPOT000.1 100702	1998 - 1 chlorine	Chlorine µg/l	11 (A&Ww)	80	1 of 1			

TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT								
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	ADEQ Stream Ecosystem Monitoring Upstream of treatment plant SCPOT000.72 100208	1998 - 1 suite	Chlorine µg/l	11 (A&Ww)	80	1 of 1		
	Friends of the Santa Cruz R. At Ruby Road SCPOT001.53 100571	1996 - 6 suites 1997 - 12 suites 1998 - 12 suites 1999 - 12 suites 2000 - 12 suites	Ammonia mg/L	Standards vary with temperature and pH. (A&Ww)	0.03 - 17.9	2 of 50		Missing core parameters: Escherichia coli, inorganics, or metals
			Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	0.5 - 14	5 of 25		
			Fecal coliform CFU/100 ml	4000 (A&Ww, AGL)	0 - 1,000,000	3 of 15		
			Turbidity NTU	50 (A&Ww)	0.9-220	2 of 27		
	ADEQ Stream Ecosystem Monitoring ½ mile N. of Fire Station B SCPOT003.38 100207	1998 - 1 suite	OK					Missing core parameters: bacteria
	ADEQ Fixed Station Network North of Nogales Fire Station SCPOT003.5 100705	1998 - 1 chlorine	Chlorine µg/l	11 (A&Ww)	30	1 of 1		
	<b>Summary Row</b>  A&Ww      Impaired FC          Attaining FBC        Attaining AgL        Impaired	<b>1996 - 2000</b>  59 samples 57 sampling events	Ammonia mg/L	Vary with pH and temp. (A&Ww)	0.03 - 17.9	2 of 52	Attaining	ADEQ and the Friends of the Santa Cruz River collected 59 samples at 6 sites from 1996 - 2000. Reach assessed as impaired due to fecal coliform. Reach should also be added to the Planning list due to chlorine exceedances, and lack of Escherichia coli samples.  Chlorine added in Nogales Wash also affecting this segment (see note above).
			Chlorine µg/l	11 (A&Ww)	40	3 of 3 (1 sampling event)	Inconclusive	
			Dissolved oxygen mg/L	6 (90% saturation) (A&Ww)	0.5 - 14	5 of 27	Attaining	
			Fecal coliform CFU/100 ml	4000 (A&Ww, AgL)	0 - 1,000,000	3 of 17 3 in 2 years	Impaired	
			Turbidity NTU	50 (A&Ww)	0.9-220	2 of 27	Attaining	
Sabino Canyon Creek headwaters-Tanque Verde AZ15050302-014 A&Wc, FC, FBC, DWS, Agl	ADEQ Biocriteria Program Above East Fork Sabino Cyn. SCSAB007.56 100635	1996 - 1 suite	Dissolved oxygen mg/l	7.0 (90% saturation) (A&Wc)	4.0	1 of 1		Missing core parameters: bacteria

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	<b>Summary Row</b> <b>A&amp;Wc</b> Inconclusive <b>FC</b> Inconclusive <b>FBC</b> Inconclusive <b>DWS</b> Inconclusive <b>AgL</b> Inconclusive	<b>1996</b>  <b>1 sampling event</b>	Dissolved oxygen mg/l	7.0 (90%saturation) (A&Wc)	4.0	1 of 1	Inconclusive	Assessed as "Inconclusive" and added to the Planning list due to dissolved oxygen not meeting standards, insufficient sampling events, and lack of bacteria samples.
Santa Cruz River Mexican border-Nogales WWTP AZ15050301-010 A&Ww, FC, FBC, DWS, AgL, AgL	Friends of the Santa Cruz R. At Guavai Ranch SCSCR091.90 100246	1996 - 2 suites 1998 - 2 suites 1999 - 1 suite 2000 - 6 suites	Turbidity NTU	50 (A&Ww)	200	1 of 1		Missing core parameters: E coli, inorganics, metals
	ADEQ Fixed Station Network At international boundary SCSCR097.28 100239	1996 - 2 suites 1997 - 2 suites 1998 - 4 suites 1999 - 4 suites 2000 - 4 suites	Dissolved Oxygen mg/L	6 (90% saturation) (A&Ww)	4.3 - 10.1 (64.1 - 126.1% saturation)	2 of 8		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment.
			<i>Escherichia coli</i> CFU/100 ml	580 (FBC)	4 - 10,000	2 of 7		
			Fecal coliform CFU/100 ml	4000 (A&Ww, AgL, AgL, DWS)	8 - 11,200	2 of 7		
			Turbidity NTU	50 (A&Ww)	0.52 - 1854	1 of 8		High flow event.
			Beryllium µg/L	0.21 (FC)	3.3	1 of 1		6 other beryllium values not included because the Laboratory Reporting Limit was too high.
	<b>Summary Row</b>  <b>A&amp;Ww</b> Impaired <b>FC</b> Attaining <b>FBC</b> Impaired <b>DWS</b> Impaired <b>AgL</b> Impaired <b>AgL</b> Impaired	<b>1996 - 2000</b>  <b>27 sampling events</b>	<i>Escherichia coli</i> CFU/100 ml	580 (FBC)	4 - 10,000	2 of 7 2 in 2 years	Impaired	ADEQ and the Friends of the Santa Cruz River collected 27 samples at two sites from 1996 - 2000. Reach was assessed as "impaired" due to bacteria contamination. Reach should also be added to the Planning List due to turbidity and beryllium exceedances.
			Fecal coliform CFU/100 ml	4000 (A&Ww, AgL, AgL, DWS)	8 - 11,200	2 of 10 2 in 2 years	Impaired	
			Turbidity NTU	50 (A&Ww)	0.52 - 1854	2 of 9	Inconclusive	
			Beryllium µg/L	0.21 (FC)	3.3	1 of 1	Inconclusive	
Santa Cruz River International WWTP-Josephine AZ15050301-009 A&Wedw, PBC, AgL	Friends of the Santa Cruz R. At Rio Rico SCSCR087.08 100238	1996 - 11 suites 1997 - 12 suites 1998 - 12 suites 1999 - 12 suites 2000 - 12 suites	Fecal coliform CFU	800 (A&Wedw, PBC, AgL)	0 - 7,700	7 of 37		Missing core parameters: metals
			Turbidity NTU	50 (A&Wedw)	0.4-150 (lab samples)	1 of 30		

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	Summary Row	1996 - 2000	Fecal coliform CFU	800 (A&Wedw, PBC, AgL)	0 - 7,700	7 of 37	Impaired	The Friends of the Santa Cruz River, under ADEQ's guidance, collected 69 samples from 1996 - 2000. Reach assessed as "impaired" due to fecal coliform. Reach should also be added to the Planning List due to missing core parameters.
	A&Wedw Impaired PBC Impaired AgL Impaired	59 sampling events  Missing core parameters	Turbidity NTU	50 (A&Wedw)	0.4-150 (lab samples)	1 of 30	Attaining	
Santa Cruz River Josephine-Tubac bridge AZ15050301-008A A&Wedw, PBC, AgL	Friends of the Santa Cruz R. At Santa Gertrudis Lane SCSCR080.50 100247	1996 - 11 suites 1997 - 12 suites 1998 - 12 suites 1999 - 12 suites 2000 - 12 suites	Fecal coliform CFU	800 (A&Wedw, PBC, AgL)	0 - 9,200	9 of 37		Missing core parameters: metals
			Turbidity NTU	50 (A&Wedw)	0.5-150 (lab samples)	6 of 31		
	Friends of the Santa Cruz R. At Tubac Bridge SCSCR077.06 100243	1996 - 3 suites 1997 - 3 suites	OK					
	Summary Row	1996 - 2000	Fecal coliform CFU	800 (A&Wedw, PBC, AgL)	0 - 9,200	9 of 45 9 within 3 years	Impaired	The Friends of the Santa Cruz River, under ADEQ's guidance, collected 69 samples from 1996 - 2000. Reach assessed as "impaired" due to fecal coliform and turbidity. Reach also added to the Planning List due to missing core parameters and investigate the extent of impairment due to turbidity.
	A&Wedw Impaired PBC Impaired AgL Impaired	59 sampling events 65 samples  Missing core parameters	Turbidity	50 (A&Wedw)	0.4-150	6 of 37 6 of 31 at Gertrudis	Impaired	
Santa Cruz River Tubac bridge-Sopori Wash AZ15050301-008B A&We, PBC, AgL	Friends of the Santa Cruz R. North of Chavez Siding Road SCSCR081.34 100244	1996 - 11 suites 1997 - 12 suites 1998 - 12 suites 1999 - 12 suites 2000 - 12 suites	Fecal coliform CFU / 100 ml	800 (A&We, PBC, AgL)	5 - 76,000	6 of 37		Missing core parameters: metals
	Summary Row	1996 - 2000	Fecal coliform CFU / 100 ml	800 (A&We, PBC, AgL)	5 - 76,000	6 of 43 6 within 3 years	Impaired	The Friends of the Santa Cruz River, under ADEQ's guidance, collected 43 samples at two sites from 1996 - 2000. Reach assessed as "impaired" due to bacteria contamination.
Santa Cruz River Canada del Oro-Guild Wash AZ15050301-001 A&Wedw, PBC	USGS NAWQA Site #09486500 At Cortaro, AZ SCSCR029.16	1996 - 8 suites 1997 - 4 suites	Dissolved oxygen mg/l	3.0 (3 hours after sunrise to sunset) (A&Wedw)	2.0 - 3.7	6 of 12		Missing core parameters: fecal coliform
	Summary Row	1996 - 1997	Dissolved oxygen mg/l	3.0 (3 hours after sunrise to sunset) (A&Wedw)	2.0 - 3.7	6 of 12	Inconclusive	USGS NAWQA Program collected 12 samples from 1996 - 1997. Reach is assessed as "inconclusive" and should be added to the Planning List due to dissolved oxygen exceedances and missing core parameters,
	A&Wedw Inconclusive PBC Inconclusive	12 sampling events Missing core parameters						

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
Sonoita Creek headwaters- 1 km blw Hwy 82 AZ15050301-013A A&We, PBC, AgL	ADEQ TMDL Monitoring At Cottonwood Springs SCSON016.4 100321	1998 - 4 nitrogen, cadmium, copper, lead, zinc, arsenic, beryllium, and mercury.	OK					
	Summary Row  A&We Inconclusive PBC Inconclusive AgL Inconclusive	1998  4 sampling events  Missing core parameters	OK				Inconclusive	ADEQ collected 4 samples in 1998. Reach assessed as "inconclusive" due to insufficient parametric coverage.
Sonoita Creek 750 ft below WWTP-Santa Cruz AZ15050301-013C A&Ww, FC, FBC, AgL, AgL	ADEQ TMDL Monitoring Above Temporal Mouth SCSON008.5 100320	1998 - 4 nitrogen, cadmium, copper, lead, zinc, arsenic, beryllium, and mercury.	Dissolved oxygen mg/l	6.0 (90% saturation) (A&Ww)	5-7 (64 - 95% saturation)	1 of 4		Staff documented that low dissolved oxygen was due to ground water upwelling that is naturally low in dissolved oxygen; therefore, not considered in the final assessment.
	Summary Row  A&Ww Inconclusive FC Attaining FBC Inconclusive AgL Inconclusive AgL Inconclusive	1998  4 samples  Missing core parameters	OK				Inconclusive	ADEQ collected 4 samples in 1998. Reach assessed as "attaining some uses" and should be added to the Planning List due to missing of core parameters.
Sycamore Canyon headwaters-Mexico border AZ15080200-002 A&Ww, FC, FBC, AgL	ADEQ Biocriteria Program Above Penasco Canyon RMSYC002.33 100660	1996 - 1 field, ammonia, cadmium, copper, arsenic, thallium, and mercury	OK					
	Summary Row	1998 1 sampling event	OK				Not assessed	Insufficient parametric coverage and sampling events to assess.
Unnamed trib to Three R Cyn. headwaters-Three R Canyon AZ15050301-xxx A&Ww, FC, FBC	ADEQ TMDL Monitoring U/S from 3R Mine - South trib. (background) SCTHC004.50 100852	1999 - 1 field, beryllium cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC)	3.7	1 of 1		
			Copper (dissolved) µg/L	5 (A&Ww)	380	1 of 1		
			Zinc (dissolved) µg/L	37 (A&Ww)	51	1 of 1		
	Summary Row  A&Ww Inconclusive FC Inconclusive FBC Inconclusive	1999  1 sampling event	pH SU	6.5 - 9.0 (A&Ww, FBC)	3.7	1 of 1	Inconclusive	Insufficient parametric coverage and sampling events to assess. Add to Planning List due to exceedances.
			Copper (dissolved) µg/L	5 (A&Ww)	380	1 of 1		
			Zinc (dissolved) µg/L	37 (A&Ww)	51	1 of 1		



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STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
Three R Canyon headwaters-end of perennial flow AZ15050301-558A A&Ww, FC, FBC	ADEQ TMDL Monitoring At mouth of Cox Gulch SCTH003.03 100322	1998 - 2 field, beryllium, cadmium, copper, zinc	Copper (dissolved) µg/L	varies A&Ww	12,500-36,200	2 of 2		No pH readings.
			Beryllium µg/L	0.21 (FC) 4.0 (FBC)	8	1 of 1		
			Zinc (dissolved) µg/L	varies A&Ww	14,800-34,500	2 of 2		
	ADEQ TMDL Monitoring Above 3R Min SCTHC004.67 100874	1999 - 1 field, beryllium cadmium, copper, zinc	Copper (dissolved) µg/L	varies (6) (A&Ww)	1400	1 of 1		
			pH SU	6.5 - 9.0 (A&Ww, FBC)	3.8	1 of 1		
	ADEQ TMDL Monitoring Below uppermost springs in 3R Canyon and 3R Mine SCTHC004.01 100872	1998 - 4 field, beryllium cadmium, copper, zinc 1999 - 1 field, beryllium cadmium, copper, zinc 2000 - 1 field, beryllium cadmium, copper, zinc	Beryllium (total) µg/L	0.21 (FC) 4 (FBC)	2.4- 5.1	2 of 2 (FC) 1 of 6 (FBC)		Other beryllium samples not used because Laboratory Reporting Limit was too high.
			Cadmium (total) µg/L	70 (FBC)	40 - 112	1 of 6		
			Cadmium(dissolved) µg/L	Varies (A&Ww)	35 - 143	6 of 6		
			Copper (dissolved) µg/L	Varies (A&Ww)	44,000 - 80,900	6 of 6		
			pH SU	6.5 - 9.0 (A&Ww, FBC)	2.9 - 3.1	5 of 5		
			Zinc (dissolved) µg/L	Varies (A&Ww)	850 - 2790	6 of 6		
	ADEQ TMDL Monitoring Above uppermost springs in 3R Canyon, Below 3R Mine SCTHC004.07 100949	1999 - 1 field, beryllium cadmium, copper, zinc	pH SU	6.5 - 9.0 (A&Ww, FBC)	3.5	1 of 1		
			Copper (dissolved) µg/L	5 (A&Ww)	7200	1 of 1		
			Zinc (dissolved) µg/L	37 (A&Ww)	110	1 of 1		
	Summary Row  A&Ww      Impaired FC          Inconclusive FBC          Inconclusive	1999  10 samples 6 sampling events  Missing core parameters	Beryllium (total) µg/L	0.21 (FC) 4 (FBC)	<0.5 - 8	3 of 3 (FC) 2 of 10 (FBC)	Inconclusive	ADEQ collected 9 samples at 4 sites in 1999. Reach assessed as "impaired" due to cadmium, copper and zinc. Reach is also added to the Planning List due to beryllium and low pH and missing core parameters.
			Cadmium (total) µg/L	70 (FBC)	40 - 112	1 of 10	Attaining	
			Cadmium (dis.) µg/L	Varies (A&Ww)	35 - 143	6 of 10	Impaired	

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS	
			Copper (dissolved) µg/L	Varies (A&Ww)	380 - 89,000	10 of 10	Impaired		
			pH SU	6.5 - 9.0 (low) (A&Ww, FBC)	2.9 - 3.1	7 of 7	Inconclusive		
			Zinc (dissolved) µg/L	Varies (A&Ww)	850 - 2790	9 of 10	Impaired		
LAKE MONITORING DATA									
Arivaca Lake AZL15050304-0080 A&Ww, FC, FBC, Agl, AgL	EPA TMDL Investigation SCARI	1998 - 2 suites, 2 sediment, 2 fish	pH SU	6.5-9.0 (A&Ww, FBC, Agl, Agl)	6.5 - 9.5	2 of 2		Sediment and fish tissue criteria not available for assessments. Missing core parameters: bacteria	
	ADEQ Lakes Program SCARI 100000	1998 - 4 suites, 1 sediment	pH SU	6.5-9.0 (A&Ww, FBC, Agl, Agl)	6.3 - 9.5	1 of 4			
			Dissolved oxygen mg/l	6.0 (90% saturation) (A&Ww)	1.8 - 12.9	1 of 4			
	AGFD Lakes Program SCARI	2000 - 1 suite	OK						
	Summary Row		1998  2 sediment samples 2 fish tissue samples 7 water samples 5 sampling events  Missing core parameters	pH (high) SU	6.5-9.0 (A&Ww, FBC, Agl, Agl)	6.3 - 9.5	3 of 7	Inconclusive	ADEQ, AGFD, and EPA collected samples from 1998 - 2000. Lake was assessed as “not attaining” because of a mercury TMDL approved by EPA in 2000. Reach added to Planning List to determine the effectiveness of TMDL strategies, exceedances of pH and dissolved oxygen standards, and missing core parameters.
	A&Ww Inconclusive FC Not attaining FBC Inconclusive Agl Inconclusive Agl Inconclusive	Dissolved oxygen mg/l		6.0 (90% saturation) (A&Ww)	1.8 - 12.9	1 of 7	Inconclusive		
Kennedy Lake AZL15050301-0720 A&Ww, FC, PBC	ADEQ/AGFD Urban Lakes Study SCKEN 100028	1998 - 10 suites 1999 - 2 suites	pH (high)	6.5-9.0 (A&Ww, PBC)	7.9 - 9.3	1 of 12		Missing core parameters: bacteria	
	AGFD Routine Monitoring up to 3 sites SCKEN	1997 - 1 suite	OK					Missing core parameters: depth, metals, bacteria, and turbidity.	
	Summary Row		1997 - 1999	pH (high)	6.5-9.0 (A&Ww, PBC)	7.9 - 9.3	1 of 13	Attaining	ADEQ and AGFD collected 13 samples from 1997 - 1999. Lake is assessed as “attaining some uses” and added to the Planning List due to missing bacteria samples.
A&Ww Attaining FC Attaining PBC Inconclusive	13 sampling events Missing bacteria samples								
Lakeside Lake AZL15050302-0760 A&Ww, FC, PBC	AGFD Routine Monitoring SCLAK	1997 - 1 suite 1998 - 1 suite	Dissolved oxygen mg/l	6.0 (90% saturation) (A&Ww)	0.9 - 1.7 (18%-176%)	2 of 2		Missing core parameters: metals, bacteria	

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				PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	ADEQ/AGFD Urban Lake Study SCLAK 100034		1998 - 12 suites 1999 - 2 suites	pH SU	6.5-9.0 (A&Ww, PBC)	7.3 - 9.8	2 of 14		Missing core parameters: bacteria
				Dissolved oxygen mg/l	6.0 (90% saturation) (A&VWw)	1.5 - 17.1 (18%-176%)	2 of 14		
	Summary Row  A&Ww      Inconclusive FC        Attaining PBC       Inconclusive		1997 - 1999  16 sampling events  Missing core parameters	pH SU	6.5-9.0 (A&Ww, PBC)	7.3 - 9.8	2 of 16	Attaining	ADEQ and AGFD collected 16 samples from 1997 - 1999. Lake is assessed as “attaining some uses” and added to the Planning list due to dissolved oxygen exceedances and missing core parametric coverage.
				Dissolved oxygen mg/l	6.0 (90% saturation) (A&Ww)	1.5 - 17.1 (18%-176%)	4 of 16	Inconclusive	
Parker Canyon Lake AZL15050301-1040 A&Wc, FC, FBC, Agl, AgL	ADEQ Lakes Program SCPAK 100057		1998 - 3 suites	OK					Missing core parameters: bacteria
	Summary Row  A&Wc      Attaining FC        Attaining FBC       Inconclusive Agl       Attaining AgL       Attaining		1998  3 sampling events  Missing bacteria samples.	OK				Attaining	ADEQ collected 3 samples in 1998. Lake assessed as “attaining some uses” and added to the Planning List due to missing core parameters.
Patagonia Lake AZL15050301-1050 A&Wc, FC, FBC, DWS, Agl, AgL	EPA TMDL SCPAT		1998 - 1 suite	Dissolved oxygen mg/l	7.0 (90% saturation)	6.5 - 6.7	1 of 1		Missing core parameters: bacteria.
	ADEQ Lakes Program SCPAT		1998 - 3 suites	OK					Missing core parameters: bacteria.
	Summary Row  A&Wc      Inconclusive FC        Attaining FBC       Inconclusive DWS       Attaining Agl       Attaining AgL       Attaining		1998  4 samples 3 sampling events	Dissolved oxygen mg/l	7.0 (90% saturation)	6.5 - 6.7	1 of 4	Inconclusive	ADEQ and EPA collected 4 samples in 1998. Lake assessed as “attaining some uses” and added to the Planning List due to missing bacteria samples.
Pena Blanca Lake AZL15050301-1070 A&Wc, FC, FBC, Agl, AgL	EPA TMDL Investigation SCPEN		1998 - 1 suite, sediment	OK					No sediment criteria available for assessments. Missing core parameters: bacteria.
	ADEQ Lakes Program SCPEN 100064		1998 - 3 suites	pH (low) SU	6.5-9.0 (A&Ww, FBC, Agl)	6.1 - 8.2	2 of 3		Missing core parameters: bacteria.

**TABLE 25. SANTA CRUZ-RIO MAGDALENA-RIO SONOYTA WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT**

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	<b>Summary Row</b>  A&Wc    Inconclusive FC       Not attaining FBC      Inconclusive Agl       Attaining AgL       Inconclusive	1998  1 sediment sample 4 water samples 4 sampling events  Missing core parameters.	pH (low) SU	6.5-9.0 (A&Ww, FBC, AgL)	6.1 - 8.2	2 of 3	Inconclusive	ADEQ and EPA collected 4 samples in 1998. Lake assessed as "not attaining" because of a fish consumption advisory due to mercury in fish tissue, and the completion and approval of a mercury TMDL in 2000. Lake is added to the Planning List for TMDL effectiveness monitoring and due to missing core parameters.
Rose Canyon Lake AZL15050302-1260 A&Wc, FC, FBC, Agl, AgL	ADEQ Lakes Program SCROS 100183	1998 - 1 suite	pH SU	6.5-9.0 (A&Ww, FBC, Agl, AgL)	6.2 - 9.2	1 of 1		
			Turbidity NTU	50 (A&Ww)	4.6 - 19	1 of 1		
	<b>Summary Row</b>  A&Wc    Inconclusive FC       Inconclusive FBC      Inconclusive Agl       Inconclusive AgL       Inconclusive	1998  1 sampling event	pH SU	6.5-9.0 (A&Ww, FBC)	6.2 - 9.2	1 of 1	Inconclusive	Lake assessed as "inconclusive" and added to the Planning List due to pH and turbidity exceedances and insufficient sampling events.
			Turbidity NTU	50 (A&Ww)	4.6 - 19	1 of 1		

### Information for interpreting these Monitoring Tables

- "Segment" designates the beginning and end points of the reach.
- "Waterbody ID" is derived from combining the following: AZ (for streams) or AZL (for lakes) + a US Geological Survey Hydrologic Unit Code + EPA stream reach number or ADEQ lake number.
- "Designated Uses," "Agency," and "Units" (of measurement) abbreviations are defined in Appendix A.
- "Site Code" is an ADEQ derived abbreviation for the surface water basin, stream name or lake name, and the location of the site. For streams, the numbers are the miles upstream from mouth (normally measured as a straight line vector).
- "ADEQ Database ID" -- This is ADEQ's water quality database reference number. If the data is not in this database, no number will be shown.
- "Samples" -- The year and number of water samples is shown. The federal "water year" is used, from October 1<sup>st</sup> through September 30<sup>th</sup>, rather than the calendar year. Types of samples:
  - < "Suite" indicates that a broad range of chemical constituents were collected and field measurements were taken (normally inorganics, metals, nutrients, and bacteria.) The chemical constituents monitored are not consistent among the many monitoring entities that provided the data. If the suite did not include the core parameters needed to assess a designated use as "attaining," the missing core parameters are indicated.
  - < "Field" indicates that only field measurements such as dissolved oxygen, pH, turbidity, and water temperature were collected.
  - < If a specific parameter or parametric group (e.g., zinc, metals, bacteria) is named, monitoring was limited to only these parameters
- "Standards Exceeded at this Site per Sampling Event."
  - < Although many parameters may be analyzed, only those exceeding a standard are shown. Other parameters were collected.
  - < "OK" indicates that no standards were exceeded.
  - < The specific standards are shown as a single parameter may have multiple standards depending on the designated uses assigned. (See standards in Appendix C.)
  - < "The Range of Results" indicates the minimum and maximum sample results. If the laboratory reported result is "less than the detection limit" or "not detected," a less than (<) value will be shown along with the detection limit (e.g., <0.5 mg/L).
  - < A mean, geometric mean, or median will be shown along with the range of results if applicable to the standard or assessment criteria.
- "Comments" include other information used in interpreting the data for assessments, such as evidence that exceedance is solely due to natural conditions, or that the data does not meet the new "credible" data requirements.
- In the "Summary Row" parameter exceedances are combined from multiple sites, and the assessment of each designated use is shown. The overall assessment for the surface water is described in the "Comments" field: "Attaining," "Not attaining," "Impaired," or "Inconclusive." See assessment criteria in Chapter III of Volume I.

## Ground Water Assessments in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed

**Major Ground Water Stressors** -- Monitoring data collected from wells in this watershed between October 1995-October 2000 are summarized in **Table 26** and illustrated in **Figures 48, 49, and 50**.

Overall, nitrates appear to be the most common contaminant affecting ground water quality in the greater Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed. Some probable sources of nitrate in ground water in this watershed would be historic agricultural application of fertilizers and wastewater disposal practices.

Although only three wells exceeded volatile and semi-volatile organic compounds standards, it is important to note that no standards have been established for many of these human-made pollutants, and 12 other wells detected volatile and semi-volatile organic chemicals (VOCs and SVOCs). Contamination sites in the Tucson and Nogales areas are being addressed under the state and federal Superfund programs and through international monitoring programs established with Mexico. Studies related to these sites are discussed in the next section of this watershed report.

Of approximately 89 wells monitored, very few other standards were exceeded (1 radiochemical, 2 fluoride, 1 metal). **Figure 48** illustrates the location of the wells monitored and the wells exceeding standards.

**TDS Concentrations** -- Water quality can be characterized based on concentration of Total Dissolved Solids (TDS). High levels of salinity limits the practical uses of ground water in some areas of this watershed as TDS over 500 mg/L has an off-flavor (23% of wells monitored), and TDS over 1000 mg/L will limit its use for some crops (7% of wells monitored) (**Figure 49 and Table 26**).

No TDS water quality standards apply in this watershed and the elevated levels of TDS do not present a human-health concern for drinking water. The TDS concentration is only used to generally characterize water quality.

**Nitrate Concentrations** -- Water quality can also be characterized by looking at the concentration of nitrates in ground water. In Arizona, natural occurring nitrate concentrations in ground water are generally below 3 mg/L and concentrations above 5 mg/L may indicate potential anthropogenic sources of nitrates. Nitrates were elevated above 5 mg/L in 21 of the 85 wells sampled (25%). As illustrated in **Figure 50**, elevated nitrates are scattered across the

watershed.

When nitrate concentrations exceed 10 mg/L, an Arizona's Aquifer Water Quality Standard has been exceeded. This standard was set to protect human health, as water with nitrate greater than 10 mg/L may present a health problem for infants and should not be consumed by nursing mothers. Nine of the wells exceeded this level. As many of the wells sampled are irrigation wells (not used for drinking water), nitrates over 10 mg/L may not represent a human-health concern in this watershed. However, efforts should be made to minimize further contamination of ground water by nitrate.



**Table 26. Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed Ground Water Monitoring 1996 - 2000**

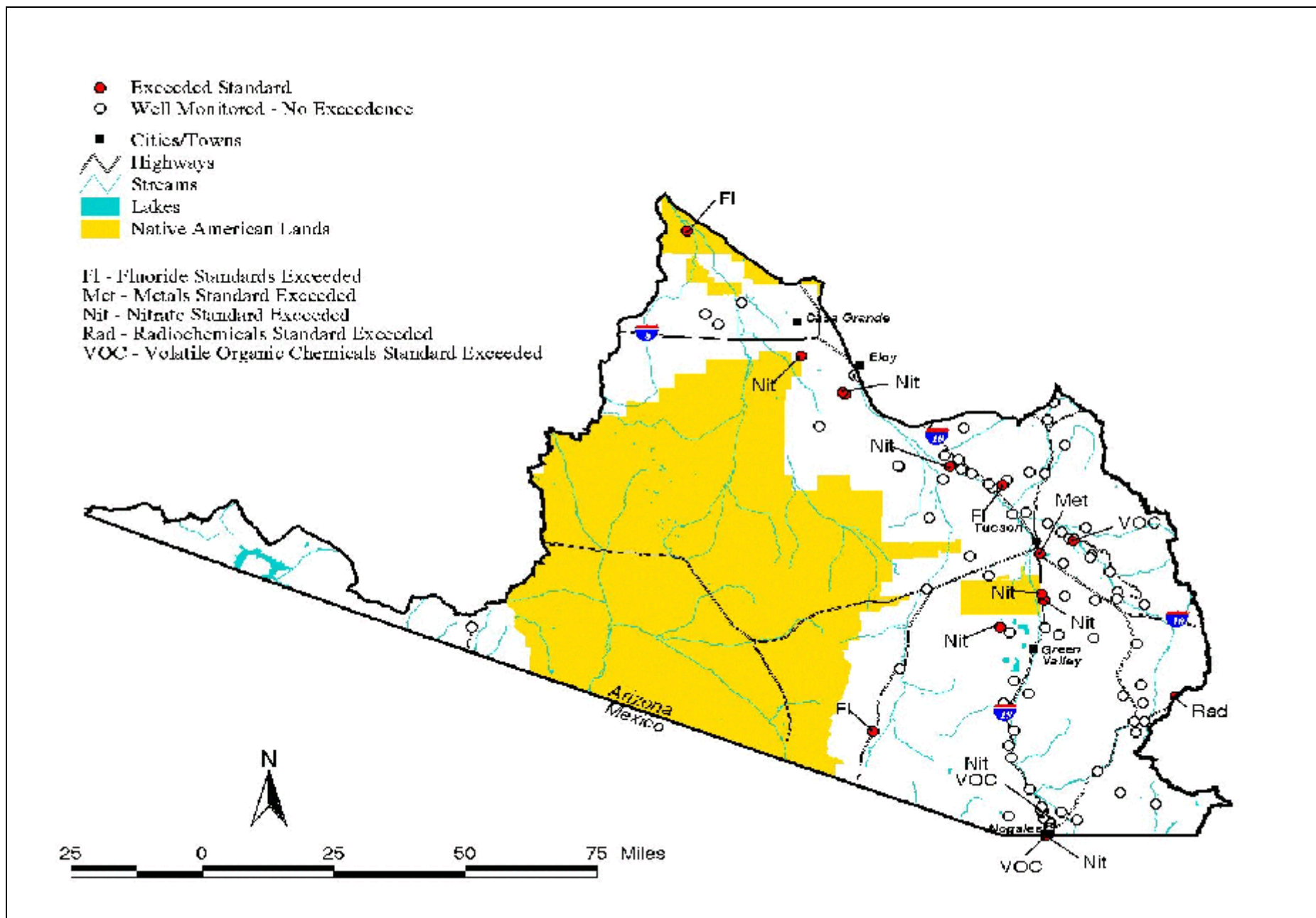
MONITORING DATA TYPE	PARAMETER OR PARAMETER GROUP	NUMBER OF WELLS			PERCENT OF WELLS EXCEEDING STANDARDS
		SAMPLED	SYNTHETIC CONSTITUENT DETECTED*	EXCEEDING STANDARDS	
INDEX WELLS	Radiochemicals	37		1	3%
	Fluoride	47		2	4%
	Metals/Metalloids	47		0	0%
	Nitrate	47		4	9%
	VOCs + SVOCs*	32	2	0	0%
	Pesticides	33	0	0	0%
TARGETED MONITORING WELLS	Radiochemicals	3		0	0%
	Fluoride	17		0	0%
	Metals/metalloids	42		1	2%
	Nitrate	38		5	13%
	VOCs + SVOCs*	32	10	3	9%
	Pesticides	25	1	0	0%

WELL CLASSIFICATION BY TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION				
Total Number of Wells	Wells <500 mg/L Acceptable drinking water flavor	Wells 500-999 mg/L Fresh (not saline) Some crop production problems	Wells 1000-3000 mg/L Slightly saline Increasing crop production problems	Wells >3000 mg/L Moderately saline to briny Severe crop production problems
55	43	11	1	0

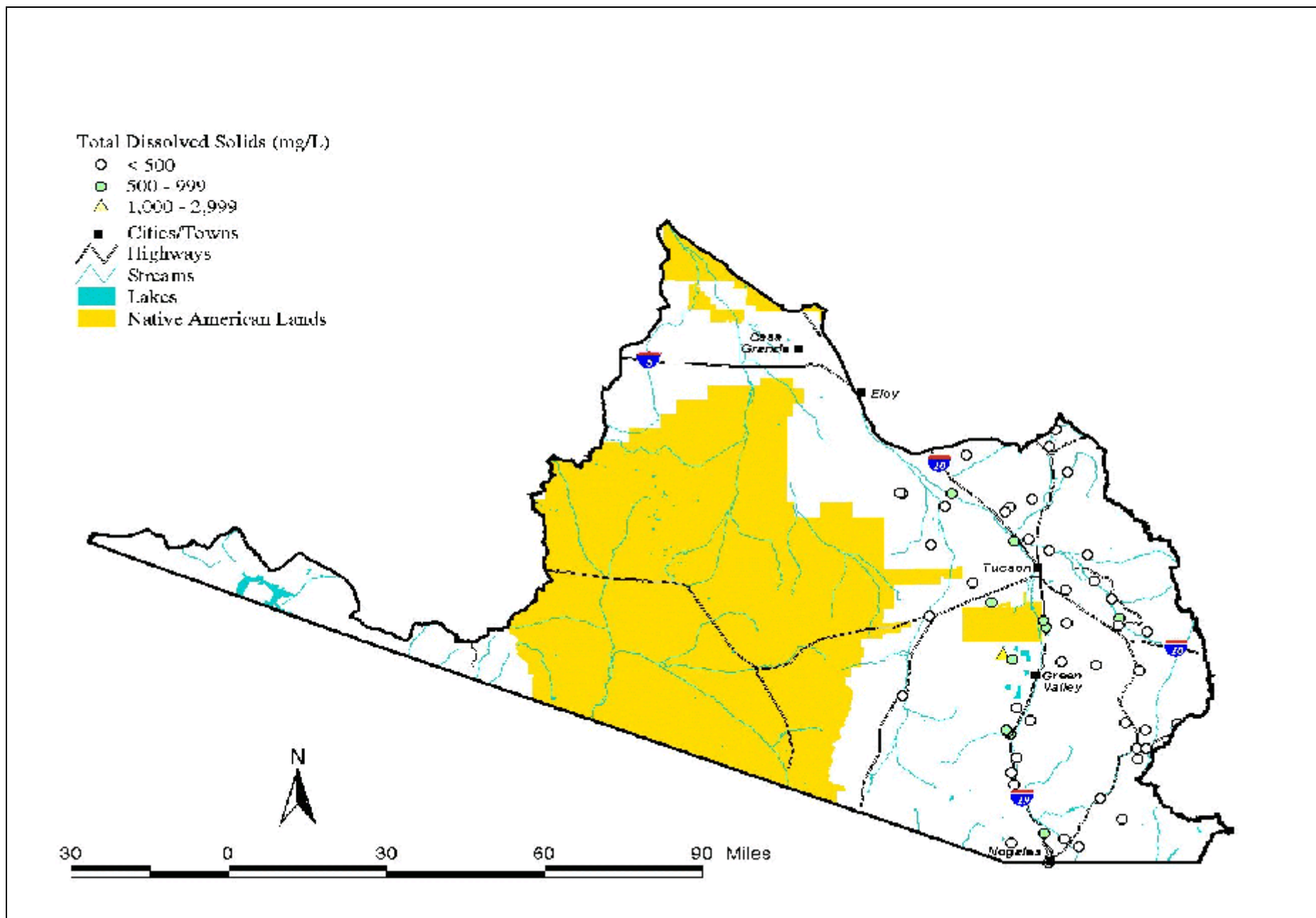
WELL CLASSIFICATION BY NITRATE CONCENTRATION (measured as Nitrogen)			
Total Number of Wells	Wells <5 mg/L	Wells 5-10 mg/L May be an anthropogenic source of Nitrates	>10 mg/L Exceeds standards Should not be used for drinking water by babies or nursing mothers
85	64	12	9

\*VOCs = volatile organic compounds; SVOCs = semi-volatile organic compounds.

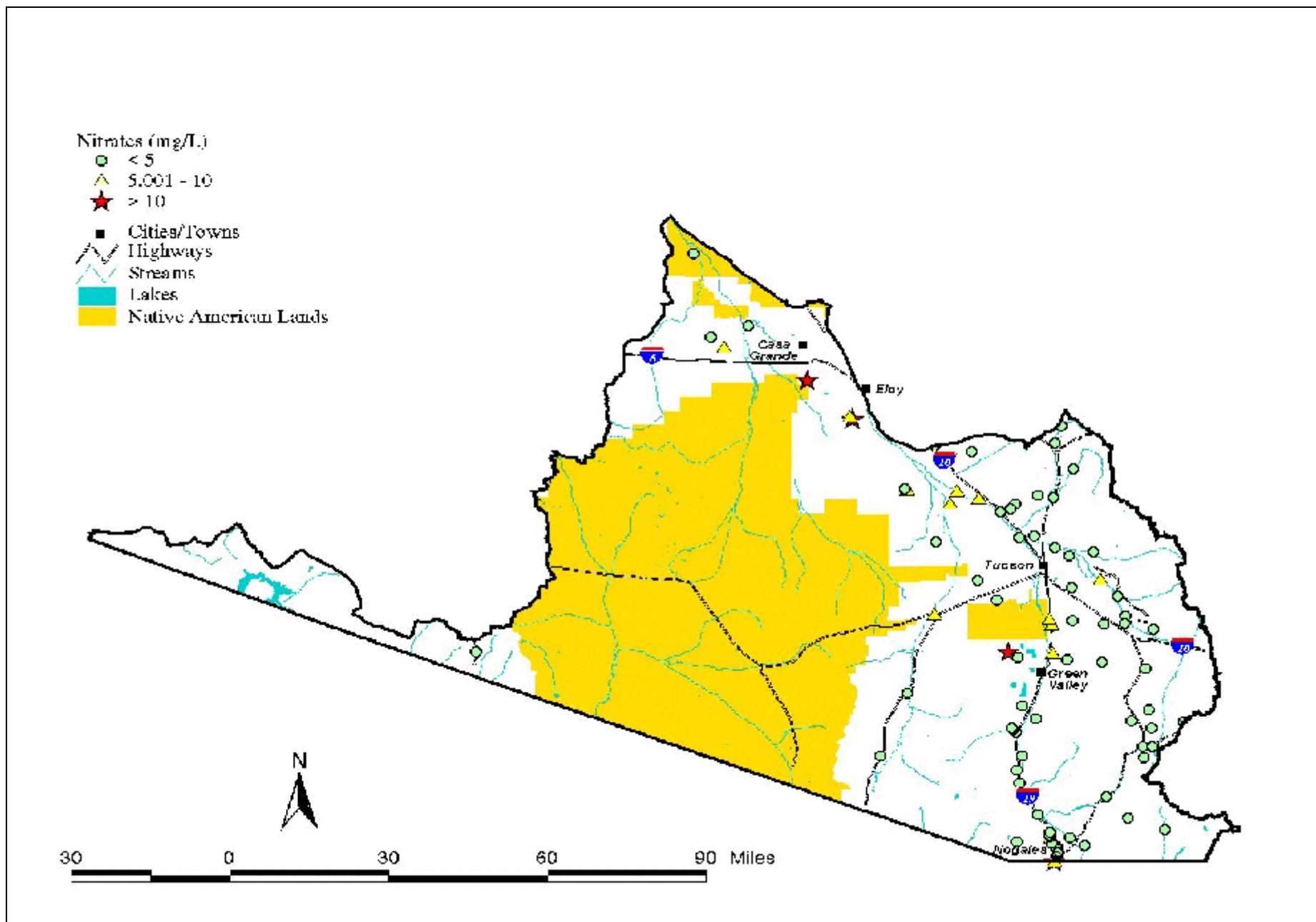
\*The detection of a synthetic constituent (pesticides, VOCs, and SVOCs) is noted because some do not have standards and these substances are not naturally occurring in the ground water.



48. Ground Water Monitoring in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed – 1996-2000



**Figure 49. Classification of Ground Water Quality by TDS Concentration in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed**



**Figure 50. Classification of Ground Water Quality by Nitrate Concentrations in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed**

# Watershed Studies and Alternative Solutions in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed

## Surface Water Studies and Mitigation Projects

This section highlights surface and ground water studies, mitigation projects, and remediation activities which have been conducted to improve water quality in the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed. Watershed partnerships active in this watershed are also mentioned.

**Total Maximum Daily Load Analyses** – The following TMDL analyses have been completed or are ongoing in this watershed. Further information about the status of these investigations can be obtained by contacting the TMDL Program manager at (602) 771-4468, or at ADEQ's web site:

<http://www.adeq.state.az.us/environ/water/assess/tmdl.html>

- Arivaca Lake Mercury TMDL – Arivaca Lake was identified as impaired because mercury was elevated above EPA's guidance for fish consumption, resulting in a fish consumption advisory being issued. Water samples did not exceed surface water quality standards because mercury readily attaches to soil particles, plants, and fish tissue. Mercury is probably in the water but at a concentration below laboratory detection limits.

A TMDL for mercury in this lake was written for and approved by the U.S. Environmental Protection Agency in 1999 (Tetra Tech Inc, 1999). The TMDL analysis indicated that Arivaca Lake was receiving mercury simultaneously from multiple sources:

- < Natural deposition from local substrates (mineral deposits);
- < Atmospheric sources; and
- < A dump site (potentially only a minor source of mercury).

This TMDL estimates that the loading capacity of Arivaca Lake is approximately 155 grams of mercury per year. A 38% reduction in background watershed loading of mercury will be needed to eventually reduce mercury burdens in fish tissue.

To meet this loading requirement within 10 years, the TMDL included the following provisions:

- < Conduct a follow up watershed survey to identify any previously undetected mercury loading sources;
  - < Initiate remedial actions if any undetected sources are identified;
  - < Implement erosion control best management practices to mitigate further contamination by soils; and
  - < Monitor fish tissue for mercury levels to evaluate the effectiveness of any remediation actions.
- Pena Blanca Lake Mercury TMDL – Like Arivaca Lake, Pena Blanca Lake was impaired because of the presence of mercury in fish tissue in excess of EPA's Fish Consumption Guidelines, with a subsequent fish consumption advisory being issued. A TMDL was written for and approved by the U.S. Environmental Protection Agency in 1999 (Tetra Tech Inc, 1999). The TMDL analysis indicated that Pena Blanca Lake was receiving mercury from:
    - < Natural deposition from local substrates (mineral deposits);
    - < Atmospheric sources; and
    - < A contaminated mine tailings pile from St. Patrick Mine (potentially a significant source) on Coronado National Forest property.

The loading capacity of Pena Blanca Lake is approximately 145 grams of mercury per year. It is anticipated that the remediation of the contaminated mine tailings will reduce mercury loading into the lake to a level sufficient that the fish consumption advisory can be removed within 10 years. Fish tissue analysis will be needed to evaluate the effectiveness of the remediation and to determine if additional actions are necessary.

- Sonoita Basin Draft TMDLs (for Alum Gulch, Harshaw Creek, and Three-R Canyon) -- Draft TMDLs are being generated for three waterbodies in the Sonoita River drainage area: Alum Gulch, Harshaw Creek (Harshaw Wash), and Three-R Canyon. All three investigations are concerned with historic mining sites and acid mine drainage (low pH, high cadmium, copper, and zinc).

Currently, these TMDLs being revised based on public comment and new data provided by the US Geological Survey. Revised reports are to be released for further public comment in July 2002.

- Sonoita Creek Dissolved Oxygen TMDL Study – ADEQ’s investigated sources contributing to low dissolved oxygen in Sonoita Creek in 1998 and determined that it was naturally occurring due to ground water upwelling. Ground water is naturally very low in dissolved oxygen. Based on this investigation, ADEQ is recommending that Sonoita Creek be removed from the 303(d) List in 2002.

**US Geological Survey NAWQA Study** – Samples were collected in this watershed as part of the US Geological Survey National Water Quality Assessment Program (NAWQA). This study included sites in the Middle Gila, Santa Cruz-Rio Magdalena-Rio Sonoyta, and Verde watersheds. (See statewide studies discussed in the beginning of Volume II.)

**The US Fish and Wildlife Service Contaminant Studies** – The USFWS has published the following three contaminant studies:

- Santa Cruz River Contaminant Study – To investigate the general decline of the endangered Gila topminnow, in 1997 the US Fish and Wildlife Service initiated an assessment of contaminant levels in water, sediment, invertebrates, fish, and birds in the Santa Cruz River (King, et al., 1999). Samples were collected from two sites upstream of the Nogales International Wastewater Treatment Plant and five sites downstream of that plant. Analytical results indicated that elevated chromium was present in both sediment, invertebrates, and fish. The study concluded that un-ionized ammonia was at levels toxic to fish at sites below the treatment plant discharge.
- Wastewater Treatment Plant Ponds in Nogales – Ducks collected from the Nogales International Wastewater Treatment Plant ponds in February 1996 contained low residues of organochlorine pesticides and polychlorinated biphenols (PCBs). Concentrations were below those known to adversely affect adult survival and reproduction. Elevated concentrations of mercury, possibly cadmium, chromium, and nickel were found in some ducks. The study concluded that the wastewater treatment plant discharge may be a source of elevated concentrations of these metals in the Santa Cruz ecosystem. However, the study noted that untreated wastes from Mexico enter the Santa Cruz River just

upstream of the treatment plant from Nogales Wash. Nogales Wash receives wastes from numerous border maquiladora industries and periodic storm flow events also flush contaminants from urban and industrial areas into the wash.

- Sonoran Mud Turtles from Quitobaquito Springs – The population of Sonoran mud turtles at Quitobaquito Springs in Organ pipe Cactus National Monument have drastically declined since the 1950s. The reason for the decline was largely attributed to inadequate food base, but analysis of tissue from eight dead turtles provided the opportunity to investigate whether organochlorine pesticides or heavy metals also played a role in their decline. Several metals and DDE were detected in the turtles, but the significance of these concentrations could not be determined and further investigations of related turtle species and the food supply at the spring ponds were recommended.

**Water Protection Fund Projects** – The following projects received Water Protection Funds from the Arizona Department of Water Resources:

- Partnership for Riparian Conservation – The Rincon Institute was awarded two grants to protect riparian areas along Tanque Verde Creek and Rincon Creek. **Phase I.** The Rincon Institute designed and implemented landowner-based strategies to identify and remediate damaged riparian areas and protect healthy ones. **Phase II.** The Rincon Institute will work with private landowners along Tanque Verde Creek and Rincon Creek on three separate projects to be completed in 2002:
  - < Design a river-friendly erosion control structure that enhances riparian vegetation reestablishment. This is to stem the loss of property, encourage bank stabilization, and promote aggradation to enhance natural regeneration.
  - < Restore riparian vegetation on two acres of former pasture land. Funding will be used for site characterization study, fencing, seed collection and propagation of revegetation materials, irrigation line construction, and site preparation and plantings.
  - < Implement a long-term riparian conservation planning and public education project.

To complete Phase I in 1998, Rincon Institute partnered with personnel from the Coronado National Forest, Saguaro National Park, University

of Arizona, U.S. Geological Survey, developers and landowners in the watershed.

- Altar Valley Watershed Resources Assessment – Altar Valley Conservation Alliance received a grant to research historic conditions, describe existing conditions, conduct detailed vegetation mapping, and produce community outreach materials for the Altar Valley. The end product was an action plan for the restoration of this sub-watershed, identifying and prioritizing problems, describing feasible remedies, and identifying potential financial means of implement improvements. This project was completed in 2000.
- Madera Canyon - Proctor Vegetation Modification – The Coronado National Forest was awarded a grant to enhance the upland conditions along Madera Canyon. The project goal is to reduce the upland mesquite overstory (with minimal harm to other tree species) and to restore the herbaceous understory to a condition dominated by native perennial grass species. This project recognizes the importance of perennial grasses to soil stability and related in-stream reduction in turbidity. Perennial grasses can also encourage beneficial water retention and rain percolation into the ground, and increase litter development and organic matter levels within the soils.

Little perennial grass understory was at this site due to shading from excessive mesquite overstory. The project removed upland mesquite trees with main stem diameters less than 5 inches, temporary restricted vehicle use in the area, enforced livestock grazing guidelines, and refurbished a stock pond to draw cattle away from the treatment and regrowth site. The project was completed in 2001.

- Santa Cruz River Headwaters Project – The San Rafael Cattle Company received funds to restore and maintain seven miles of riparian and wetland corridor of the Santa Cruz River headwaters. Fences and water developments are to be constructed to control and manage livestock grazing in the riparian corridor. The project was completed in 2001.
- Oak Tree Gully Stabilization Project – Coronado National Forest was awarded funds to treat 30 headcuts in the Oak Tree Canyon and Empire Gulch (tributaries to Cienega Creek) by reshaping the gullies and decreasing flow velocity and energy. The headcuts appear to be the result of forest service roads and unauthorized vehicular use and a

source of turbidity in Cienega Creek. The project was completed in 2001.

- Cienega Creek fencing at Empire Ranch (Empire/Cienega/Empirita fencing project) – Empire Ranch was awarded Watershed Protection Funds to improve livestock management which will benefit the health of the Cienega Creek ecosystem. These improvements included: extending an existing fence, separating sacaton benches, creating a livestock enclosure for monitoring, realigning a degraded road, and creating an alternate wildlife and livestock water source. The project will be completed in 2002.
- Cienega Creek Restoration Project – The US Bureau of Land Management received funds to remove an unused agricultural diversion canal and re-establish flow through the Cienega Creek channel. Disturbed areas were revegetated using plants salvaged at the site. The project was completed in 1999.
- Cienega Creek Restoration Evaluation Project – ADEQ was awarded funds to survey Cienega Creek. Data generated at these sites will be used to better understand erosive processes of dryland streams, a significant problem throughout the state. The project is to be completed in June 2003.
- Lower Cienega Basin geological model refinement project – Arizona Geological Project refined the geologic model for the lower Cienega Basin, located southeast of Tucson. The geologic model is an important component of a computer model used to predict the impact of ground water pumping within a basin on perennial and intermittent stream flow. This research project was completed in 1996.
- Hay Mountain Watershed Rehabilitation – A private owner was awarded funds to install four miles of pipelines and three 10,000 gallon water storage tanks with drinkers, rip and seed native grasses, reshape and recontour two erosion sites, and to install a variety of flood control structures. These watershed improvements are designed to reduce flooding and erosion by increasing infiltration of rainfall into the soil. The project will be completed in 2002.

The grantee is working with the Natural Resource Conservation Service, the Arizona State Land Department, the Douglas Whitewater



Draw Conservation District, Rocky Mountain Elk Foundation, and the Arizona Game and Fish Department to restore and rehabilitate the Hay Mountain sub-watershed (approximately 1000 acres) on the NI Ranch. This sub-watershed is located northwest of Douglas in the southeastern part of the state. The site suffers from over-grazing, with reduction of native grasses and subsequent increases in overland flow. The ephemeral streams have increased width-depth ratios, increased sediment transport and some gullying within the larger arroyos.

- Puertocito Wash Rehabilitation Project on the Buenos Aires National Refuge – The Arizona Conservation Voters Habitat Fund received funds to rehabilitate Puertocito Wash, an eroded ephemeral stream on the Buenos Aires National Refuge. Two gabions were constructed along the stream course and native grasses were re-established. The project was completed in 1999.
- Upper Santa Cruz Watershed Restoration – Lazy J2 Ranch proposes to install fencing and water developments by June 2003 to more evenly distribute livestock grazing impacts throughout the A Bar Draw Allotment in the San Rafael Valley. Nine dirt tanks will be cleaned. Three tanks provide habitat for the endangered Sonoran Tiger Salamander, and would be fitted with sediment traps, and partially fenced to exclude livestock use. The applicant will reconstruct two corrals to treat livestock without moving them to headquarters, two miles to the west.

According to the Forest Service, the allotment has insufficient vegetative cover and litter accumulation, which results in increased runoff and suspended sediment, and decreased water percolation. This degraded condition is the result of drought and improper grazing management grazing management by the prior permittee.

- Santa Cruz River Park Extension Project – The City of Tucson received funds to create a riparian and upland riparian habitat on a denuded 50 acre lot at the confluence of Irvington Wash and the Santa Cruz River. Seven acres near the wash will be planted with native riparian vegetation, and the remaining 40 acres will be mesquite bosque. Vegetation will be established and supported with tertiary-quality reclaimed wastewater. The city is also to design and build a public access trail system with interpretive signs.

- Atturbury Wash Project – The city of Tucson Water Department was awarded Watershed Protection Funds to establish a sustainable five-acre riparian habitat along a one-half mile tributary of Atturbury Wash within Lincoln Regional Park. Secondary effluent produced at the city's Roger Road Reclaimed Wastewater Treatment Plant will be the source water for this project. The project has three major objectives:
  - < Create interconnected wetlands and shallow ponds that will support planted emergent vegetation and create wildlife habitat;
  - < Provide information on the capacity of small scale wetlands to reduce nitrogen levels in reclaimed wastewater; and
  - < Provide water quality data down gradient of the wetlands.
- Redrock Riparian Improvement Project – Coronado National Forest was awarded funds to improved riparian conditions and expand Gila topminnow habitat in the Redrock Canyon watershed through a series of rangeland improvements. Fencing is to be replaced, an off-stream livestock water source is to be established, a cattle enclosure is to be extended, and a road will be rerouted to allow continued access by motor vehicles outside of the enclosure. The project is to be completed by 2003.
- Rillito Creek Habitat Restoration Project – The City of Tucson is to restore a mesquite bosque along a portion of the Rillito River, and provide recreational and educational opportunities for schools and the public. City staff will guide neighborhood and educational groups in the revegetation and maintenance efforts. This project will use reclaimed water to establish native plants. The project is to be completed in 2003.
- Cortaro Mesquite Bosque Project – Eight (80) acres of riparian habitat is to be established by Pima County Flood Control District on the flood plain terraces in the Town of Marana along the Santa Cruz River. The vegetation is to be irrigated by effluent from two Pima County wastewater treatment plants with supplemental irrigation from tributary flow ponded on the flood plain terraces. This project is to be completed in 2003.
- Potrero Creek Wetland Characterization and Management Plan –



EnviroNet, Inc. received funds to determine the source of water that sustains the wetland and riparian area along Potrero Creek, and to determine factors critical to its continuation as a wetland. The project also included a biologic and hydrogeologic evaluation of the area's potential for habitat improvement or habitat replication, and the development of a wetland management plan. The project was completed in 1997.

- Riparian Restoration on the San Xavier Indian Reservation – The San Xavier District of the Tohono O'odham Tribe evaluated various options for restoring riparian areas on their lands. Sites for riparian restoration were chosen based on physical and biological conditions and community preference. A restoration plan was developed. The project was completed in 1999.
- Sabino Creek Riparian Ecosystem Protection Project – In 1998, the Hidden Valley Homeowners Association received Watershed Protection Funds to measure stream flow in Sabino Creek in support of an application for non-consumptive, in-stream flow water right for a reach of Sabino Creek. The project area is a privately owned natural riparian park owned by the homeowners association in Tucson.

**Sonoran Desert Conservation Plan** --The Sonoran Desert Conservation Plan “combines short-term actions to protect and enhance the natural environment with long-range planning to ensure that our natural and urban environments not only coexist but develop an interdependent relationship where one enhances the other. The action plan will guide approved public bond investment and preservation actions, establish federal program and funding priorities, and develop our region's preference for the expenditure of State funds to preserve and protect State Trust lands threatened by urbanization.” This plan has led to the following projects.

- The Cienega Creek Natural Preserve – Nearly 4000 acres along a 12-mile long reach of Cienega Creek has been acquired to preserve one of the region's few remaining perennial streams. Establishment of the preserve in 1986 marked Pima County's first major flood control effort that included riparian habitat preservation. In response to eliminating cattle grazing and off-road vehicle activity, the density of cottonwoods, willows and other trees and shrubs along the stream have increased

dramatically and channel erosion has decreased and water quality has decreased.

- Over 23 miles of river parks have been constructed along the Santa Cruz River, Rillito Creek, and Tucson Diversion Channel. These parks are used by thousands of people each week to relax and exercise. The channel bottoms offer one of the few locations for horse use in the growing urban area.
- Pima County Flood Control District Projects -- Other water course protection will be explored when the Pima County Flood Control District works with landowners to protect the flood prone areas from future development through conservation easements and acquisitions. Using bonds approved by voters in 1997, lands along Sabino Creek, Honey Bee Wash, Bear Canyon, Tanque Verde Wash, San Pedro River, and Agua Caliente Wash will be preserved, protecting and/or enhancing water quality. Pima County will encourage the setting aside of state trust land along significant corridors such as Cienega Creek, Mescal Arroyo, Davidson, and Penitas Wash, among others.
- The “Pantano Jungle” Restoration Project -- This project is to re-establish vegetation typical of mesquite woodland and riparian grassland on a site along Pantano Wash (formerly known as the “Jungle”) that was cleared for pasture. Native trees and grasses are now being planted to improve the nature of land for wildlife use. Volunteers have installed check dams and other measures to reduce erosion. The project is funded by the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department.
- Rillito Recharge and Habitat Restoration – This project helps restore wetlands and riparian habitat along the south bank of the Rillito river west of Swan Road using reclaimed treated wastewater will be transported from the Roger Road treatment plant. A park will be constructed on the north bank of the river. On-site storm water runoff will also be directed to the wetlands as well as to vegetated areas around them. In addition, Pima County Flood Control Department and the City of Tucson are cooperating on two other projects just upstream: a pilot recharge project and wildlife habitat project (see Water Protection Fund projects discussed above).
- Tucson/Ajo Detention Basin – A 27 acre wetland and riparian habitat is

to be constructed in a 120-acre flood control basin located just north of Ajo Way and west of Country Club Road in Tucson. A state-of-the-art stadium, Tucson Electric Park, opened in 1999. This park is irrigated with reclaimed wastewater effluent and storm water captured in the basin.

- The City of Tucson and Pima County have agreed to set aside up to 10,000 acre-feet of treated effluent per year for riparian projects. The effluent can be delivered to sites via the reclaimed water system or other means.
- Agua Caliente Restoration – Habitat for large, self-sustaining populations of native aquatic animals can be recreated at Agua Caliente park. This project is being studied by the US Army Corps of Engineers and Pima County.
- Cienega Creek Stream Flow Restoration Project -- One to five miles of stream flow could be restored by acquiring a one-acre inholding within the Cienega Creek Natural Preserve, transforming what is now an ephemeral stream into a lush riparian area similar to other reaches within the Preserve. The inholding contains two key features, a surface-water diversion dam and a well as a stream flow gaging station used by the U.S. Geological Survey and Pima County Flood Control District. By acquiring the inholding and the associated water rights, the stream can be made whole again. To do this, the Vail Water Company will need a replacement source of water for its development, either ground water pumped from outside the preserve, effluent, or Central Arizona Project Water (CAP).
- The Rincon Creek Restoration Project – This project is located south of Saguaro National Park's Rincon Mountain Unit. A 600-foot wide riparian-woodland corridor along two miles of the creek is to be restored using a combination of private and public funding. The project is a requirement of Pima County Zoning and Section 404 permits. Most of the native trees and shrubs have been removed and the stream channel has been destabilized due to farming and erosion without the use of visually or physically intrusive structures. Other restoration components include planting, ground water monitoring, and removing livestock. A multi-use trail system within the restore flood plain will provide access to Saguaro National Park.

**Water Quality Improvement Grants** – ADEQ awarded the following Water

Quality Improvement Grants in this watershed.

- Santa Cruz River Sediment Control – This project is to restore 1000 feet of the Santa Cruz River channel that runs through the Santa Fe Ranch. This site is five miles northeast of Nogales. The project is designed to reestablish a healthy riparian corridor that functions to filter sediment and other non-point source pollutants from the river channel while increasing channel stability by installing Kellner jacks for grade stabilization and by revegetation of riparian areas. An educational component includes workshops, brochures, and newsletters. For more information contact the Coronado Resource conservation and Development Area, Inc. at (520) 384-2229.
- The Rillito Wash Recharge and Habitat Restoration Project – This project is to restore wetlands and riparian habitat, whereby improving water quality, along the south bank of the Rillito River west of Swan Road. A park will be constructed on the north bank of the River. Water supply for the project will consist of reclaimed treated wastewater transported from the Roger Road Treatment Plant. On-site storm water runoff will be directed to the wetlands as well as to vegetated areas around them. In addition, the Pima County Flood Control District is cooperating with the City of Tucson on two other projects upstream -- a pilot recharge project and a wildlife habitat project, both of which will be located on District land east of Swan Road. Cooperators include Pima County, City of Tucson, and the U.S. Army Corps of Engineers.

## Ground Water Studies And Mitigation Projects

**The Upper Santa Cruz Basin Study** – Fifty-eight ground water samples were collected and analyzed in 1998 by the U.S. Geological Survey and ADEQ to assessing ground water quality and identify contaminant sources within the Upper Santa Cruz Basin (Coes, et al., 2000). At least one constituent exceeded state water quality standards in 29% of the samples collected. These constituents included arsenic, fluoride, nitrite (plus nitrate), iron, manganese, pH, sulfate, and dissolved solids.

Factors influencing the regional ground water quality include aquifer depth and proximity to major faults and anthropogenic factors such as recharge from agricultural uses. For more information, please contact the ADEQ Ground Water Monitoring Unit at (602) 771-4412.

**Casa Grande Area Study** – Situated in Pinal County, the Casa Grande study area encompassed more than 24 square miles. This study area included areas where recent residential development has been concentrated and there is a potential for elevated nitrate levels.

In this study, ADEQ concluded that elevated nitrate levels exist in the northern and southwestern portions of the study area. Potential sources may include malfunctioning septic systems, wastewater discharges, and agricultural runoff. These may also be the sources of elevated levels of chloride, sulfate and total dissolved solids. Elevated levels of arsenic, fluoride and pH may be due to the weathering of sediments derived from igneous rocks. For more information, please contact the ADEQ Ground Water Monitoring Unit at (602) 771-4412.

**Hydrogeologic Investigation of Sonoita Creek** – The Nature Conservancy was awarded Watershed Protection Funds to generate Hydrogeologic data from ground water monitoring wells and assist in determining sources of ground water discharge that sustain base flow in the perennial reach of Sonoita Creek. The project looked at ground water movement and sources of base flow in Sonoita Creek and implemented a long-term monitoring program.

**Federal and State Superfund Cleanup Sites** – Twelve WQARF, National Priority List, and Department of Defense Superfund cleanup sites are located in this watershed.

- Tucson International Airport Area – This 24 square mile area contains seven major project areas including: Air Force Plant 44, Tucson Airport Remediation Project, the Airport Property, the Arizona Air National Guard 162<sup>nd</sup> facility, Texas Instruments Tucson Corporation, the former West Cap property, and west plume B. Ground water investigations have defined a contamination plume in the regional aquifer consisting mainly of trichloroethene (TCE), with smaller amounts of dichloroethene (DCE), chloroform, and chromium. This plume extends from Air Force Plant 44 north past Irving Road. Ground water pump-and-treat systems and soil vapor extraction systems are among the treatment technologies presently being employed to address contamination of soils and ground water in the area.
- 162 Air National Guard Site – The Arizona Air National Guard 162<sup>nd</sup> Tactical Fighter Group occupies 84 acres of the Tucson International Airport Area site, along Valencia Road in Tucson. the base has been a

training facility for tactical fighter aircraft. The primary ground water contaminant at this site is trichloroethene (TCE). Approximately 110 gallons per minute is being pumped from the ground water, treated, and then reinjected into the ground. A soil vapor extraction system was started on April 3 1997 and shut down on November 29, 1997, after achieving complete soil remediation.

- Raytheon Air Force Plant # 44 – The Raytheon Air Force Plant #44, located in the southern portion of the Tucson International Airport Area, is a federally owned weapons manufacturing facility operated under contract by the Raytheon Corporation (formally Hughes). Historic waste disposal operations at the plant resulted in soil and ground water contamination of metals and volatile organic compounds including trichloroethene (TCE). Remediation activities include large-scale pumping, treating, and reinjecting ground water; soil vapor extraction systems; dual-phase extraction systems; and soil excavation and removal.
- Davis Monthan Air Force Base – The entire Davis Monthan Air Force Base in Tucson is included in the Department of Defense study site. Contamination at the base has been primarily surface soil contamination with petroleum wastes, waste piles of hazardous aluminum dross, and a large volume underground jet fuel leak. Aluminum dross on the base (residue from past melting of obsolete aircraft) has been treated by solidification-stabilization, and has been transported to an off-site landfill.
- Broadway-Pantano site – The Broadway-Pantano site is located in east-central Tucson and includes 130-acre Broadway North Landfill. This site was first put on the WQARF Registry in 1998. Ground water is contaminated by tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride at concentrations exceeding Arizona's aquifer protection standards and drinking water standards. PCE and TCE are volatile solvents commonly used in dry cleaning and metal cleaning operations, and vinyl chloride is often an end product when PCE and TCE chemically decomposed in the environment.
- El Camino del Cerro site – This site in northwest Tucson contains the closed 20-acre El Camino del Cerro Landfill. It was placed on the WQARF Registry in 1998 primarily due to contamination by tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride,

benzene, and methane.

- Los Reales Landfill site – The Los Reales Landfill is an active municipal sanitary landfill in southeast Tucson. The site was placed on the WQARF Registry in 1999 with ground water contamination by volatile organic compounds. Several VOCs have been detected in down-gradient monitoring wells, including: tetrachloroethene (PCE), trichloroethene (TCE), trichlorofluoromethane, dichlorofluoromethane, chloroethane, 1,1-dichloroethene (DCE), methylene chloride, and 1,1-dichloroethane (DCA). Up-gradient wells have not had detectable levels of VOCs.
- Miracle Mile site – The Miracle Mile site in Tucson was placed on the WQARF Registry in 1998 with ground water contamination by at least seven different volatile organic chemicals. The predominant contaminants are trichloroethene (TCE), tetrachloroethene (PCE), dichlorodifluoromethane (Freon 12), trichlorofluoromethane (Freon 11), 1,1-dichloroethene (DCE), and methyl tertiary butyl ether (MTBE). Benzene and chromium have each exceeded Arizona’s aquifer protection standards in at least one well at the site.
- Park-Euclid site – This site in Tucson includes facilities on South Park, where several companies conducted laundry and dry-cleaning operations since the late 1930s. The site was placed on the WQARF Registry in 1999. Ground water contamination is a combination of diesel free product and volatile organic compounds, including tetrachloroethene (PCE), trichloroethene (TCE), and 1,1-dichloroethene (DCE).
- Shannon Road - Rillito Creek site – This Tucson site extends approximately one quarter mile north and south of Rillito Creek. This site was placed on the WQARF Registry in 1999 with ground water contamination by tetrachloroethene (PCE), trichloroethene (TCE). As remedial investigations proceed, the extent of contamination will be further defined. Other VOCs have been detected at this site but below regulatory limits.
- Silverbell Jail Annex Landfill – This site was placed on the WQARF Registry in 1999. Investigations have discovered a ground water plume consisting of solvents tetrachloroethene (PCE), trichloroethene (TCE). Other VOCs routinely detected in monitoring wells include vinyl chloride, dichlorodifluoromethane, trichlorofluoromethane,

methylene chloride, and cis-1,2-dichloroethene (DCE).

## Watershed Partnerships

**Friends of the Santa Cruz River** – The Friends of the Santa Cruz River was established by community members to “preserve and enhance water quality and perennial flow of the upper Santa Cruz River.” Member volunteers have helped ADEQ collect fecal coliform and chlorine samples in the upper Santa Cruz River. The data generated was used in making assessments in this report

For information about meetings and activities, contact Mark Larkin at (520) 398-9093.